POWER

Volume 57 New York, May 1, 1923 *Number* 18

The Convention Season

THE season of Spring Meetings and Annual Conventions is upon us, and committees are busy arranging programs and entertainment, and members and delegates are preparing papers to read and discussions to shoot them full of holes.

These meetings are great opportunities. They increase the radius of a man's life by extending his acquaintanceship, his knowledge of places and people and the subjects that are discussed. They fill up and enrichen the lives and experience of the participant by contact with the leaders of thought and achievement in his particular line, by the strengthening of existing friendships and the induction of thought processes which make him capable of better service to the world and a better companion to himself.

As I look about among the men in big positions, I realize that many of them have found their chance in life, or rather that their chance has come to them, from the impressions that they have made and the worthwhile acquaintanceships that they have formed upon occasions of this kind.

It is not the frivolous junketer at a convention who makes this kind of an impression nor the fellow who fills the most pages in the proceedings and says the least.

But the man who thinks thoughts that interest others, the man of ideas, finds here the chance for self expression. The studious observer and seeker for information not only finds the means of increasing his knowledge, but is himself being observed by those seekers for dependable service who are always looking for a "comer."

And the man who goes to conventions in this kind of a spirit will carry away some of the benefits that collectively justify the convention habit.

F. R. Low

Solid-Injection Oil Engine Investigations in Sweden

An Account of the Experimental Work of K. J. E. Hesselman, Swedish Diesel Designer, in the Development of the Hesselman Solid-Injection Oil Engine—Particular Emphasis Is Laid on Fuel Atomization Tests

By EDVIN LUNDGREN, M. E.

THE old problem of injecting the fuel into the cylinder of an oil engine directly by means of a pump without the use of compressed air, has encountered many serious difficulties, and the great number of failures to solve this problem have created a prejudice against the solid-injection engine. Even after successful solid-injection engines have been built, prominent authorities on this subject, including the German professors, Loffler and Riedler, maintain in the most categorical manner that a simple injection of the fuel by means of a pump is not sufficient to obtain a good distribution of the fuel within the air content of the cylinder during the short time available for this purpose.

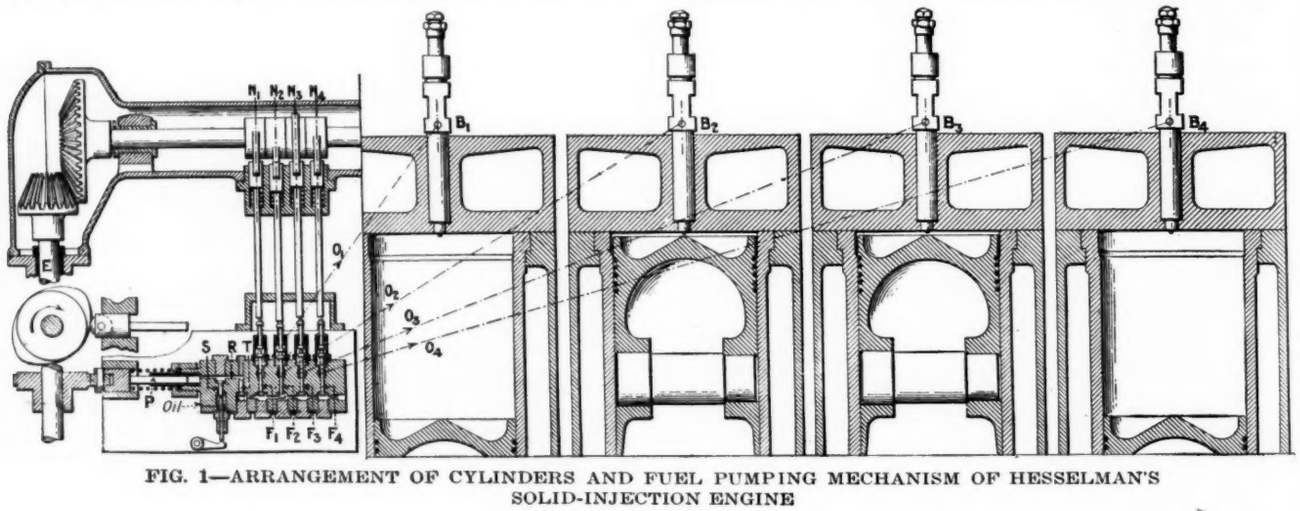


FIG. 1—ARRANGEMENT OF CYLINDERS AND FUEL PUMPING MECHANISM OF HESSELMAN'S SOLID-INJECTION ENGINE

Most of the solid-injection failures have been due to the fact that the designers followed one leading idea without paying sufficient attention to the multitude of apparently minor factors which complicate the question. The engineering spirit of today is, however, characterized by its analyzing and scrutinizing of every minute detail. It is this modern stamp of scientific study and logical reasoning which distinguishes the work of K. J. E. Hesselman, leading to the design of a new solid-injection engine. To contribute to a clearer understanding of this type of engine, some of the statements made by Mr. Hesselman in a paper read before the Swedish Technological Society in Stockholm will be reiterated.

In the Diesel engine a proper amount of fuel is stored in the fuel valve, and upon opening of the needle valve this fuel is carried along by the compressed air which rushes into the cylinder with the high velocity of about 1,000 ft. per sec. This velocity of the oil-and-air spray is soon annihilated in the highly compressed cylinder air, but the turbulence caused by the inrushing air effects a good mingling of the fuel charge with the cylinder air. The combustion, once started, is rapidly propagated into the interior of the oil clouds. This flame propagation is favored by the turbulence of the air, but to a certain extent is slowed down by the low temperature of the cold injection-air, which is further cooled down by its expansion from 900 to 500 lb. per sq.in. A retardation of the combustion may be produced intentionally in order to obtain an expansion at a uniform pressure or to avoid a violent detonation if the fuel has been injected too suddenly, but as a rule it entails a certain belated combustion and a higher fuel consumption. For this reason a rapid combustion and a slight detonation are to be preferred, even if accompanied by a certain rise in pressure.

A too rich oil content of the air exerts a similarly retarding influence upon the combustion, as it naturally requires more heat to gasify a larger amount of fuel, and therefore, the rise of the temperature as well as of the pressure occurs more slowly. This explains why Diesel engines often show a more quiet combustion at high overloads.

While the injection of the fuel by means of highly compressed air must be considered as a good and reliable method, which is sufficiently proved by its continued long use, it is by no means the ideal method. Certain improvements through the use of rational solid-injection systems are feasible, aside from the considerable advantages of a simpler mechanical construction and a far easier attendance by reason of the omission of the injection-air compressor.

If compressed air is to be avoided for fuel injecting, some other means must be devised to effect a gradual introduction of the fuel and a good mixture of the oil with the air. The points to be observed in attempting this aim are best discussed by referring to Hesselman's actual design, which is diagramatically shown in Fig. 1.

As developed by Mr. Hesselman, the fuel is forced into the working cylinders by a simple pump, the main feature of which is that it has only one single plunger *P* even when used on a multi-cylinder engine. The pump

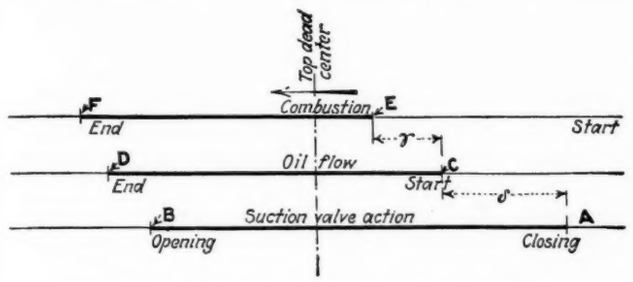


FIG. 2—TIME LAG IN OIL FLOW AND IGNITION

must therefore run with as many delivery strokes as ignitions or power strokes required in the whole engine. The pump has a single suction valve *S* and also one main delivery valve *T* leading to the distributing chamber. From the distributor the fuel is assigned to each cylinder by corresponding mechanically operated distributing valves F_1 to F_4. The engine is governed by closing the pump suction valve at a certain point of the plunger stroke and opening it again as soon as the plunger has delivered a definite amount of fuel corresponding to the load. Immediately after closing the suction valve, the pump plunger raises the oil pressure to that prevailing in the distributing chamber, whereupon the main pump delivery valve opens. One of the distributing valves, say F_2, has already opened by the cam N_2 so that the passage to the fuel valve B_2 through piping O_2 is clear, and the fuel valve is opened by the oil pressure and admits the fuel to the cylinder.

Determining Oil Flow Lag

The diagram Fig. 2 shows the sequence of these processes. The vertical center line indicates the upper dead center of the crank, and the horiztonal lines running from the right to the left, correspond to the angular motion of the crank. The points *A* and *B* on the lower line indicate the moments when the suction valve of the pump closes and opens again; *C* and *D* on the intermediate line show the opening and the closing of the fuel valve, and on the upper line the beginning of the combustion is marked at *E* and its end at *F*. The angles δ and γ thus correspond to the time elapsing between the closing of the pump suction valve *S*, Fig. 1, and the beginning of the injection, and between the beginning of the injection and of the ignition, respectively. For the proper adjustment and operation of an engine these angles are of the greatest importance, and the engine designer should know the factors determining their size.

The angle δ has been measured by a special indicating device, designed by Hesselman and shown in Fig. 3. The fuel valve was taken out of the engine, but was connected to the fuel pump by its usual piping. Right below the orifice of the fuel valve a small plate *G* was suspended and moved as it was struck by the forthcoming fuel stream. The movement of this plate was transmitted to a pen which described a line on the paper of an indicator drum, which was driven from the main shaft of the engine. This line clearly indicates the beginning and the termination of the injection. The angle δ is then easily determined, as there is no difficulty in ascertaining the exact position of the crank at which the suction valve of the pump closes.

Conclusions Drawn from Tests

Among the results of the experiments with this arrangement the following ones are of great general interest: Within certain limits the diameter of the pressure piping has no great influence on the size of the angle δ. Neither does the length of the piping exert any great influence, for the pressure wave is propagated through the fluid with a very high velocity, which is pronouncedly dependent upon the speed of the pump plunger in that very moment when the main delivery valve opens and establishes the communication between pump barrel and piping. That part of the angle which corresponds to the compression of the fuel within the pump is insignificant, which implies that the angle δ is fairly independent of the pressure at which the fuel valve opens. The actual size of the angle seems to be due principally to the hydraulic resistance offered to the propagation of the pressure wave by the sudden changes of direction in the valves. The angle can hardly be computed, but must be determined experimentally, which, however, needs to be done only once for each engine design.

A great number of experimental investigations were carried out, such as the determination of the hydraulic resistance of pipes of different diameter, using oil of different viscosity and also finding reliable values for

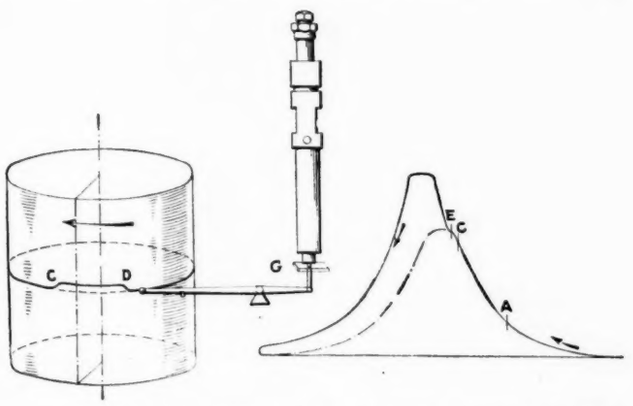


FIG. 3—FINDING OIL-FLOW LAG δ AND IGNITION LAG γ

the coefficient of discharge for holes used in the sprayers of oil engines.

As already mentioned, the propagating velocity of the pressure wave is proportional to the pump-plunger speed, which in its turn is proportional to the speed of the engine; that is, to its number of revolutions per minute. On the other hand, the time corresponding to a certain angle increases as the engine speed decreases. As the length traversed by the pressure wave through the piping remains constant and, moreover, is equal to the product of the propagating velocity by the time, the interesting observation is made that the angle δ for a certain engine is constant and entirely independent of speed variations of the engine. In other words, the

fuel is always injected at the same position of the crank, no matter how slow or fast the engine is running.

The crank angle γ, corresponding to the time interval between the beginning of the injection and that of the ignition, may be determined by offset indicator diagrams, such as is shown at the right in Fig. 3, provided the angle δ has been found. It is of the highest importance to keep the angle γ as small as possible in order to prevent an excessive accumulation of unburnt fuel within the cylinder, but the deciding factors for this angle are of a more complicated nature and not as clearly defined as those determining the angle δ. They comprise among other things, the degree of compression in the cylinder and the temperature of the oil fuel, but of more importance is the manner of introducing the fuel in the cylinder, the pulverization of the fuel, etc. The smallest angle γ found by Hesselman during a large

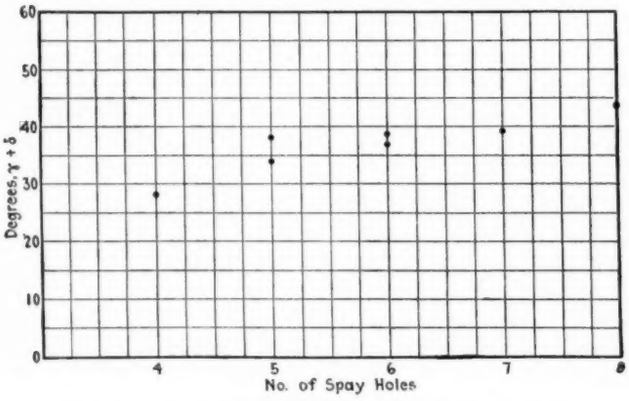


FIG. 4—EFFECT OF NUMBER OF SPRAY HOLES ON LAG ANGLES

number of experiments was 2½ deg., corresponding to a time of $\frac{1}{700}$ sec., but usually the angle is larger and the time amounts to $\frac{1}{400}$ to $\frac{1}{500}$ of one second.

Change in Number of Sprayer Holes

An interesting relation was found to exist between the angle γ—that is, the timing of the ignition—and the number of holes in the sprayer. This relation is shown in Fig. 4, where the abscissas indicate the number of holes, varying between four and eight and the ordinates represent the sum of the angles δ and γ. As the angle δ during all these tests was constant, the difference was caused exclusively by the angle γ; that is, by the different timing of the ignition. It will be noticed that the ignition is earlier when the number of holes is small, or in other words, the more concentrated the oil is at the beginning of the injection. It may be stated, by the way, that the timing of the ignition does not play a very important part with respect to the fuel consumption. The main point is to adjust the ignition in such a manner that the engines run smoothly without any tendency to knock. It is of course understood that the timing of the ignition affects the maximum pressure in the engine, and on this account it demands a certain consideration.

A most important question arising is, Which manner of injecting the fuel is the most efficient to effect a proper distribution of the fuel? The designer's first thought was to accomplish a perfect atomization of the fuel and so inject it as fine mist in the form of a cone. But a mere inspection of such a cone formed by injecting into the open air showed the futility of such a method. The fuel mist possesses entirely too little energy to penetrate compressed air, and besides, the formation of a regular conical fuel mist is easily disturbed by trifling accidental factors.

After this, Hesselman examined the practicability of using a sprayer in connection with an automatic valve, and provided with a limited number of fine holes, similar to the flame plate used on Diesel-engine fuel valves. It was found that by proper dimensioning the seat of the valve in correct proportion to the requirements of the various physical qualities of the spring, a valve could be made which gave satisfactory service and which within wide limits acted independently of the diameter of the holes in the sprayer and their coefficient of discharge. The proper design of such a valve involves a rather heavy throttling of the pressure in the opening of the fuel valve. Tests with the experimental engine have confirmed these calculations.

Variation in Oil Pressure

The difference between the pressure p_3 within the nozzle and the pressure p_2 in the cylinder is determined by the amount of fuel to be delivered in a certain time, by the area of the holes in the burner or sprayer and by their coefficient of discharge. The pressure p_1 prevailing in the fuel valve should during the injection be kept as uniform as possible and only slightly exceed the pressure at which the valve opens. The pressure p_2, on the other hand, varies between the amount of the compression at the start of the injection and a certain maximum, whereupon the pressure is equalized to that one prevailing in the cylinder by the time the valve closes. The pressure excess in the nozzle, $p_2 - p_3$, may, for the largest amount of fuel delivered, vary between 1,200 and 3,000 lb. per sq.in. without exerting any noticeable influence on the pressure p_1 in the fuel valve and on the quantity of fuel actually delivered each moment.

In order to obtain a clear conception of the injection procedure, the fuel under varying pressures was forced into the free air through holes of the size actually used in the sprayer. At low pressure the stream produced displayed a bright, coherent aspect and did not diffuse before it had reached a certain distance from the nozzle, whereas with increasing pressure this distance continually decreases, until at a certain pressure the fuel spreads immediately at the nozzle.

Penetration of Oil Drops

A rough calculation of the motion of small fuel globules under atmospheric conditions as well as at a pressure of 135 lb. per sq.in. and at a temperature of 60 deg. F., which approximately corresponds to the density of the air in the cylinder during the injection period, gives very significant results. It was discovered that when an oil globule, 0.0004 in. in diameter and with an initial velocity of 4,000 ft. per sec. is ejected into atmospheric air, it loses its entire energy after 0.02 sec. During an equal time the same globule will not penetrate more than $\frac{3}{8}$ in. into air of 135 lb. per sq.in. pressure. The velocities of drops with a diameter of 0.004 in. and even of 0.04 in. are considerably decreased within the short time mentioned. It deserves particular attention that the distances traversed are increased but comparatively little when the initial velocity is made twice as high; this is, of course, due to the fact that the resistance increases in proportion to the square of the velocity.

On the basis of these calculations and observations

the assumption seems justified, that the stream produced by the injection of a certain amount of fuel per second into a space filled with compressed air, penetrates this air only to a certain depth, which up to a definite limit increases with the decrease of the diameter of the orifice used as well as with the increase of the pressure, and which thereupon again decreases. That maximum depth may be termed the "maximum penetrating power" of the stream. This penetrating power increases with the amount of fluid injected per second.

From the preceding considerations the following practical conclusions may be drawn: It is of no use to provide the sprayer with a great number of holes and thereby divide the fuel into too many fine streams, as each stream must have a certain energy and must carry a certain amount, or, to express the same thing differently, to diminish the diameter of the sprayer holes below a certain size. A series of experiments confirmed these conclusions; tests of sprayers having from four to eight holes with a total area varying within wide limits, always showed the best results independently of the discharge area when the sprayers had five holes. In a similar way Hesselman has in ordinary Diesel engines invariably obtained the lowest fuel consumption with sprayers having eight holes.

Although a minimum of fuel consumption was obtained for a certain diameter of the holes, rather considerable deviations to either side of this size caused but an insignificant increase in the fuel consumption. This means that the unavoidable small variations in the diameter of the sprayer holes remain without any practical consequence.

Spray Valve Design

It has already been pointed out that a perfect atomization of the fuel stream, which at the first glance appears to offer an ideal solution of the problem, cannot give good results. Nevertheless, some careful tests were made with such an atomized-fuel injection, obtained by a spiral groove in the fuel valve, but smokeless combustion could never be obtained. The explanation of this is that a considerable quantity of finely distributed fuel is not able to penetrate the compressed air, but must stay in the immediate neighborhood of the sprayer, where it does not come into contact with the air necessary for its combustion. But after all, the most important object is to enable each particle of the fuel to meet its proper share of oxygen in the air. How this end is accomplished in a very efficient manner is shown in the following:

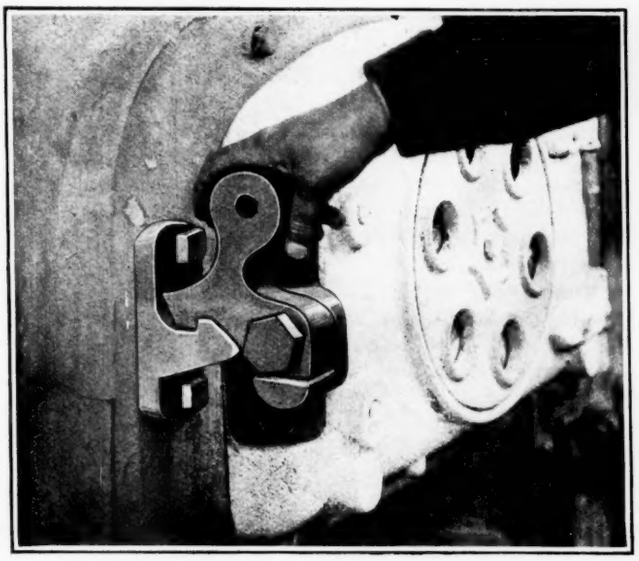
The fuel, leaving the orifices of the sprayer with a high velocity, has still a very low temperature and offers but a comparatively small surface for absorbing the heat from the surrounding hot air. The farther the small fuel globules move away from the sprayer the larger their total surface becomes and the more heat is absorbed, with the effect that the outer shell of the globule soon becomes gasified. The resistance of the compressed air immediately tears this gas from the moving oil particle, which in this way continually decreases in size, while simultaneously its velocity decreases, until at a certain distance from the sprayer the latter is entirely lost. It would seem reasonable to assume that the greater part of the fuel is gasified and burnt in the neighborhood of this distance where the heat of the air has the most chance, time and surface to act on the fuel. The combustion space should have such a form as to facilitate this action.

Furnace Door Latch Holds Against Internal Pressure

In order to prevent the furnace door from being blown open by a tube explosion or similar accident, the latch shown in the figure has been modeled on quite different lines from the familiar type on furnace doors.

Flexibility inherent in the long pivoted latch arm is here avoided. The latch arm in the figure is short and mounted close to the keeper with a pivot bolt in the most favorable position for taking the holding strain in a direct manner, so as not to produce forces that would tend to open the latch.

The latching faces of both the keeper and the latch arm are vertical instead of being in a slanted position, as in many familiar types. All the parts are steel, making for compactness and rigidity. The weight at the top of the latch arm, which also serves as a handle,



COMPACT STEEL LATCH INSURES FURNACE DOOR CLOSURE

provides a positive locking force. The moving part is mounted with no undesirable looseness or lost motion, in contrast to the older type of latch. This assists in preventing the latch from being thrown upward when the door is slammed, so it cannot rest on the upper edge of the keeper.

The De Waters safety latch can be easily opened in a natural manner; the weight at the top does not heat undesirably, so that it may be handled without gloves in ordinary operation. The mechanism consists of three parts—the keeper, the latch rocker arm, and the latch rocker-arm support, all of which may be easily mounted at the furnace door. This type of latch has been in commercial operation for two years, and has been tested at the laboratories of the National Board of Fire Underwriters, where its operation was thoroughly satisfactory. It has been approved by the industrial commissions of many states. It is manufactured by The De Waters Safety Latch Company, Inc., 5 Beekman St., New York City.

Don't fail to shut the water off the ammonia condenser after it is shut down, especially if it is old and likely to leak, as the water will absorb the gas and the leaks go undiscovered.

Operation of a Slow Speed Elevator Electric Motor Controller

A DETAILED explanation is given of the controller's operation, after which a number of the troubles that may develop are enumerated and shown how to locate them.

BY CHARLES A. ARMSTRONG

ELECTRIC elevators in their development have taken on an almost countless number of combinations of machines, motors and controllers. Many of the earlier types were straight- and cross-belt driven machines operated from manually started and stopped motors belted to lineshafts. From this crude piece of equipment the elevator machine has developed into one of the triumphs of modern engineering skill. Elevator machines and controllers can be had today that are not only completely automatic in their operation from a push button, but will also open and close the shaft doors and car gate automatically for the passengers. Furthermore, instead of occupying a goodly part of a loft floor with belts, shafting and machinery, the machine can be set in a space of a few feet square over the hoistway.

An interesting arrangement of elevator machine, motor and controller, although not the most modern, is shown in Fig. 1. The elevator machine is designed and built by the Warsaw Elevator Co., with a Cutler-Hammer Manufacturing Co. controller. The motor *M* is connected to the wormshaft by a silent-chain drive *D* which allows the use of a considerably higher-speed motor than with direct drive. As this machine is essentially a slow-speed equipment, up to about 75 ft. per min. and capacities up to 12,000 lb., the use of a silent-chain drive to give a slow speed to the wormshaft has advantages, since it obviates the necessity of driving the winding drum through an internal gear from the worm gear.

This machine is operated by a hand rope from the car which is attached to wheel *W*. When the operator in the car pulls the operating cable, he turns wheel *W* through part of a revolution and with it the eccentric and sprocket wheel *S*. The sprocket wheel is connected to a drum-type reversing switch *R*, and the eccentric connects to the brake through rod *C*. The other parts of the controller are the potential switch *P*, for opening and closing the main-line circuit to the motor, and the controller *A* for cutting out the starting resistance. The potential switch is shown in Fig. 2. When the switch closes, the carbon contacts *A* make first and the copper contacts *C* last. On opening, the copper contacts *C* open first and the carbon contacts last, so that any arcing due to opening or closing the switch will be on the carbon and not on the copper. This prevents the copper contacts from fusing and holding closed. Contacts *D* are closed when the switch opens and complete the armature circuit through a resistance to obtain dynamic braking action and to help the mechanical brake bring the elevator to rest.

A wiring diagram for the control equipment is shown in Fig. 6. On the reversing switch, parts *A'*,

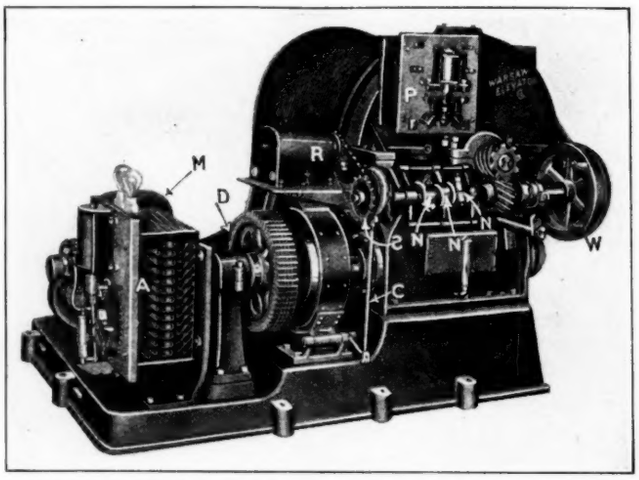


FIG. 1—ELEVATOR MACHINE AND CONTROL EQUIPMENT

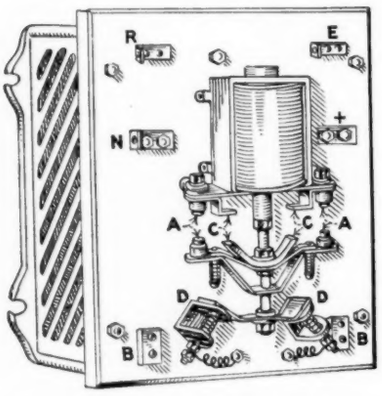


FIG. 2—POTENTIAL SWITCH FOR OPENING AND CLOSING THE CIRCUIT

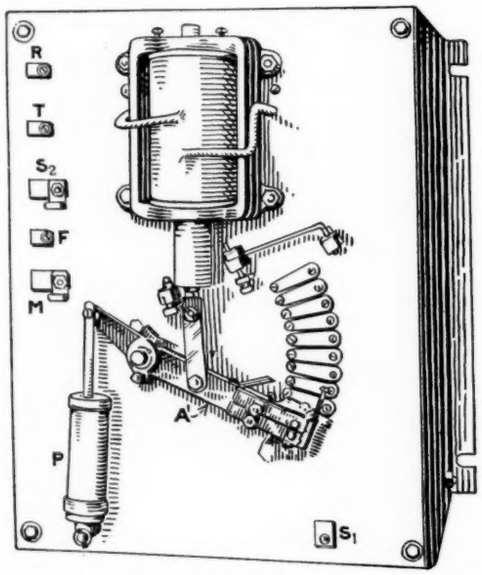


FIG. 3—CONTROLLER FOR STARTING MOTOR AND BRINGING IT UP TO SPEED AUTOMATICALLY

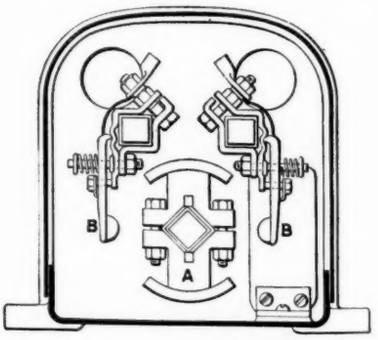


FIG. 4—SECTION THROUGH SWITCH FOR REVERSING THE MOTOR

N', A_1', S', T' and E' are all segments of circles. The reverse switch is shown with the cover removed in Fig. 5; and an end view is given in Fig. 4. The movable part A can be turned in either direction to make contact with fingers B. When the operator pulls the hand cable to the on position, these segments complete the circuit, as indicated in Fig. 7. With the reverse switch in the position shown, the armature circuit is closed from A to N and from A_1 to S_2. When the operator pulls the hand cable to the opposite position, the reverse-switch segments close contacts A and S_2 and also A_1 and N,

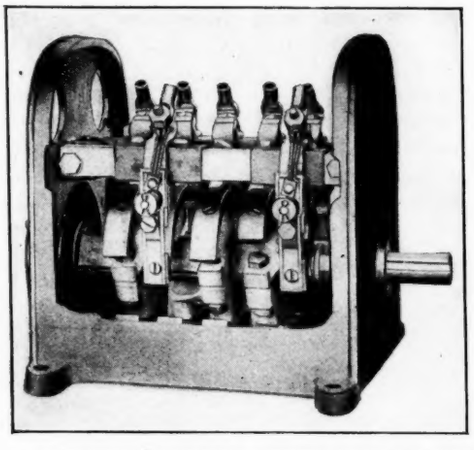


FIG. 5—REVERSING SWITCH WITH COVER REMOVED

thus completing the circuit through the armature in the opposite direction, resulting in a reverse motion of the car.

When the reverse switch is pulled to the position shown in Fig. 7, the first circuit energized is that for the potential switch coil. This circuit is from the + side of the line through coil C and contacts T and E on the reverse switch, to the controller through arm A' and to the — side of the line, as indicated by the arrowheads. This energizes the potential switch coil and causes it to close its contact between + and N, as in the figure, which completes the motor circuits. The armature circuit is from the + to the N terminal on the potential switch, from the N to the A contact on the reversing switch, through the armature back to the A_1 terminal on the reversing switch, through the series field and to S_1 on the controller, through all the starting resistance R' to terminal M and to the — side of the line. The shunt-field winding is connected directly across the line from F_1 to F and to the — side of the line switch. The circuits being complete, the motor starts with all the starting resistance in circuit. A circuit for coil C' on the controller is completed from the top contact on the potential switch to terminal R, coil C', resistance AB to the — side of the line. Energizing coil C' causes it to pull up its core and with it arm A'. As arm A' is moved across the contacts, starting resistance R' is cut out of circuit and the motor comes up to speed. When the operator pulls the hand cable to the off position, the motor is disconnected from the line and the brake is applied. To assist the mechanical brake to bring the elevator to rest, a resistance R_b is connected across the armature when the potential switch opens, as indicated in Fig. 6. When the armature is in motion, it causes a current to flow through the resistance, which produces a retarding affect, called dynamic braking. When approaching the terminal landings, if the operator fails to bring the operating cable to the off position, the car will strike stop balls on the cable and stop the elevator, or the traveling nut N' on the machine, Fig. 1, will engage one of the stationary nuts N, and center the operating mechanism, after which stopping is the same as when the operator performs the operation.

The rate at which arm A' on the controller is moved over the contacts is governed by the adjustment of an oil dashpot shown at P, Fig. 3. When the arm moves onto the last contact, it opens a connection between A and B and cuts resistance R_1 in series with coil C', Fig. 8. When arm A moves off the first contact of the controller, it cuts resistance R_2 in series with coil C on the potential switch. It will be seen that these resistances are not cut in series with coils C and C' until after the coils have pulled up their cores, which allows a comparatively large current to flow through the coils to create a strong pull for the closing operation, after which the current is reduced for holding the cores up. This allows the use of a much smaller coil than would be possible if they had to be connected directly across the line all the time, and it also results in a saving of power during the holding periods.

During the starting period the motor series-field winding is in circuit, which assists in developing a strong torque for starting the load. After the motor comes up to speed and the starting resistance is cut out, when arm A' moves onto the last contact the series-field winding is cut out of circuit. This does two things; first, it increases the speed of the motor and secondly, it prevents the machine from racing in the down motion under heavy loads. When a heavy load is being lowered in the car, the motor becomes a generator and supplies

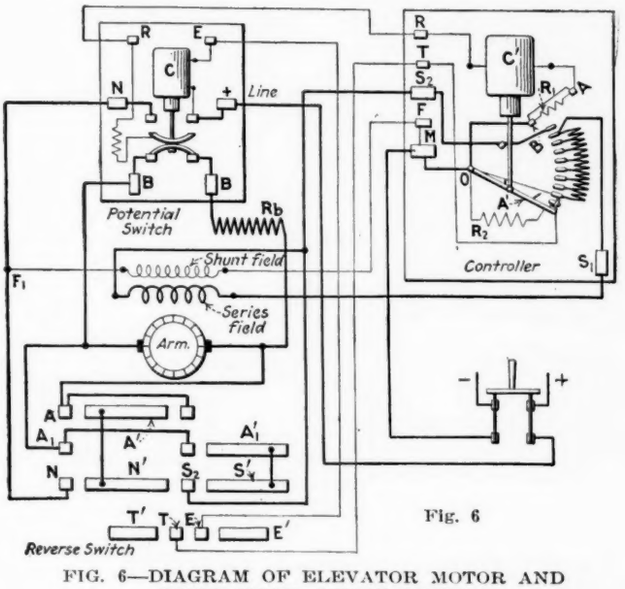


Fig. 6

FIG. 6—DIAGRAM OF ELEVATOR MOTOR AND CONTROLLER CONNECTIONS

current back into the system, which causes the motor to act as a brake and prevents the speed from becoming excessive. If the series winding were in circuit, the current flowing through it would be in opposition to that in the shunt winding and weaken the field strength of the pole pieces and allow the load to race the motor. If the speed of an elevator becomes unstable, one thing that may be looked for is to see if the series winding is being cut out of circuit.

When the potential-switch circuit is first closed, it

is completed through arm A', as in Fig. 7, and does not pass through resistance R_2. Similarly for coil C', its circuit is completed through the contact between A and B and need not pass through the resistance R_1 connected between these two points, as in Fig. 8. It is evident that these resistances might be open and the coils could function all right and pull up their cores. In the case of the potential switch it would close in a normal manner, but when arm A is moved off the first contact, resistance R_2 is cut in circuit. Should this resistance be open-circuited, coil C' will be de-energized and caused to drop its contact and arm A' will come back to the starting position. However, as soon as arm A' comes to normal position it bridges resistance R_2 in series with the potential switch coil, and this switch closes again; but as soon as arm A' moves off the first contact, the potential switch opens owing to the open circuit in resistance R_2. As long as the reverse switch is left in the on position, the potential switch will continue to close and open at intervals of one or two seconds. It is evident that such a condition would indicate an open circuit in R_2. In the earlier type of controller incandescent lamps were used as resistance, and it was not an uncommon thing for a lamp to burn out and produce the effect outlined in the foregoing.

When coil C' is first energized, the resistance R_1 is shunted out of circuit. Arm A', as it moves onto the last contact, opens the bridge across resistance R_1 and cuts it into circuit. Should this resistance be open-circuited, coil C' circuit would be opened and arm A' begin to fall; but as soon as it has moved off the top contact, resistance R_1 is bridged and the coil circuit energized again, which will pull arm A' onto the top contact only to be released again by cutting resistance R_1, which is open-circuited, back in series with coil C'. From this it is seen that as long as the reverse switch remains in the on position, arm A' will continue to oscillate between the top and the next to the top contacts, and will give an indication of an open circuit in R_1 resistance.

Locating trouble in an elevator controller is very much a case of watching how the equipment performs after the trouble occurs. For example, if the potential switch did not close, it would indicate one of two things —that the main-line circuit was open somewhere or that the potential switch circuit was open. The first suggestion can be checked by testing with a lamp at the switch and fuses. If it is found that power is on the wires running from the switch to the controller, then test across the points where the other ends of the wires connect. In Fig. 7 one line connects to the potential switch and the other to the M terminal on the controller, therefore if the circuit is alive, a lamp connected between these two points should light. If a light is obtained between these two points and the potential switch fails to function, it is an indication that the circuit of coil C is open somewhere. One terminal of coil C connects to the + line and the other to E on the potential switch. If the circuit to the coil is complete and a lamp is connected to + and E, it should light when the reverse switch is in the on position. Failure of the lamp to light would indicate an open circuit external from the potential switch.

Should controller arm A' not come down on the last contact, resistance R_2 will be in circuit with the potential-switch coil C, and this coil will not be strong enough to close its contacts. However, if the potential switch is closed by hand, the coil will hold it closed. If contact T' in the reversing switch made good connection to E and T and E' did not, then the potential switch would close for one direction of motion but would fail to close when the operating cable was pulled to the other on position.

If any of the main contacts in the reversing switch failed to make contacts the motor would not start when the switch was moved to that position, although the potential switch would close and the controller arm be pulled up. An open circuit in the starting resistance — for example, between points 1 and 2, Fig. 8—would cause the motor to fail to start until arm A' moved onto contact 2. This would complete the armature circuit with part of the starting resistance out of circuit, which might cause the fuse to blow and contact 2 to burn. If the fuse did not blow, the motor would start with a jerk and probably sparking at the brushes.

On any elevator controller troubles that might and do occur could be enumerated almost indefinitely. However, from this statement the conclusion should not be

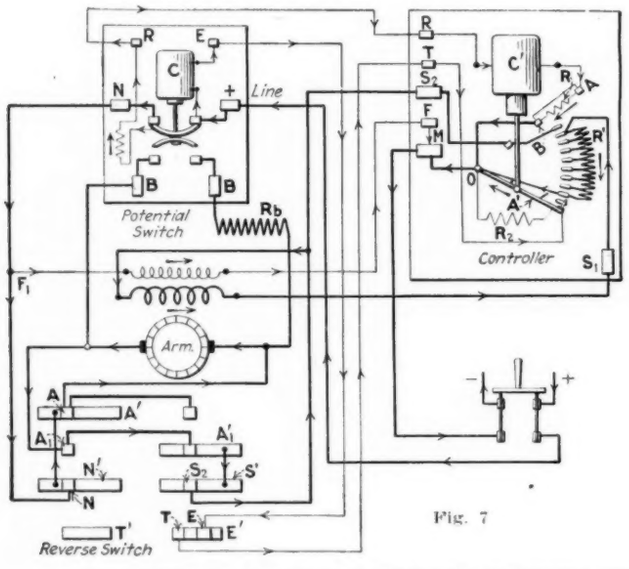


Fig. 7

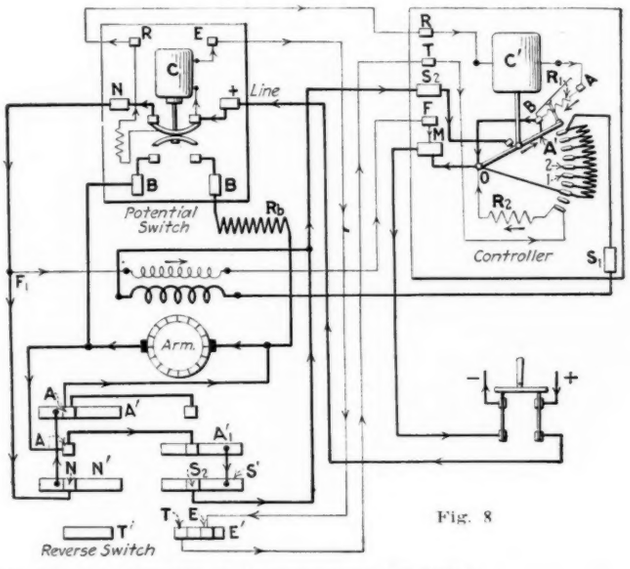


Fig. 8

FIGS. 7 AND 8—CONTROLLER CIRCUITS DURING THE STARTING AND RUNNING PERIODS

drawn that elevator controllers are troublesome and unsatisfactory equipment, for when they are properly designed, constructed and installed for the service they are to perform, they give a high degree of reliability when properly maintained. Of course, control equipment that will give a high degree of satisfaction in service where it is called upon to function a few times per day, may fall down badly in elevator applications where it may be required to operate practically continuously. One could ask for no better assurance of the reliability of the modern elevator controller than the elevator service rendered in a modern building.

New Playford Traveling Grate Stoker

While the new Playford forced-draft traveling grate stoker recently developed by the Rosedale Foundry and Machine Co., of Pittsburgh, is not a radical departure from present practice, it incorporates some new features and refinement in design not previously applied to this type of stoker.

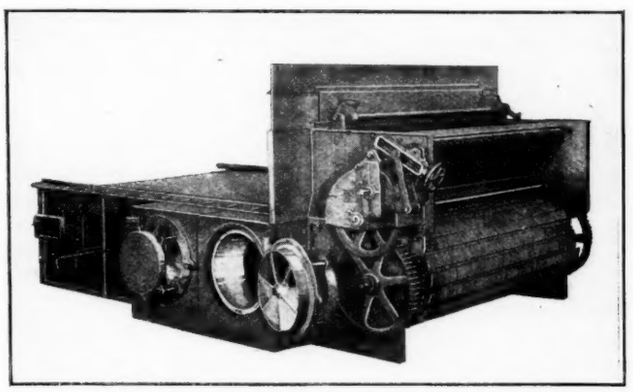


FIG. 1—GENERAL VIEW OF STOKER

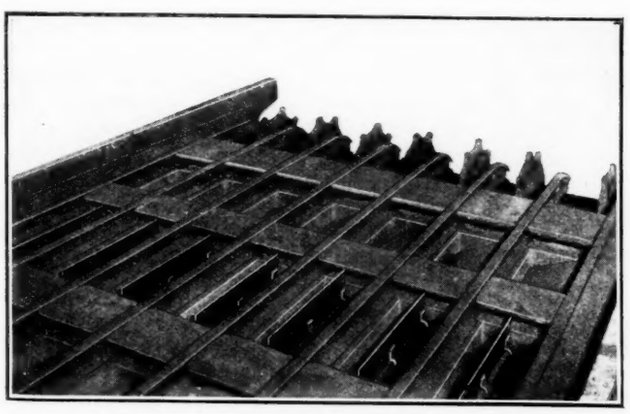


FIG. 2—AIR SUPPLY TO FUEL BED IS CONTROLLED BY SYSTEM OF SHUTTER DAMPERS

Probably the most important of these features is the method of air control, which is somewhat more elaborate than any used heretofore. Instead of admitting the air direct into a number of wind-boxes or partitions across the width of the stoker, usually termed zones, the entire interior of the grate is one large air chamber into which the air from a duct or from direct-connected blowers is admitted. This chamber serves as a reservoir, permitting the air introduced to equalize as to pressure, thereby eliminating the trouble caused by the velocity and the impinging effect of the air, such as is common with some systems of zoning.

A system of shutter dampers extending across the width of the grate, a complete set for every three feet in length of grate, controls the quantity of air delivered to the fuel bed. The arrangement of these dampers, which are located between the skid rails, is clearly illustrated in Fig. 2, which shows one set of dampers open and all others closed. All dampers are controlled by outside levers. This arrangement provides a flexible air control and enables operating from a banked fire to a high-boiler rating within a comparatively short time. It also permits variable rates of combustion at different points of the grate by adjusting the dampers to suit the conditions desired.

In Fig. 1 is shown a general view of the stoker. The method of operation and of driving the stokers is much the same as in other stokers of this type. When independent direct-connected blowers are used for supplying the forced-draft air, they are hinged to the side of airbox.

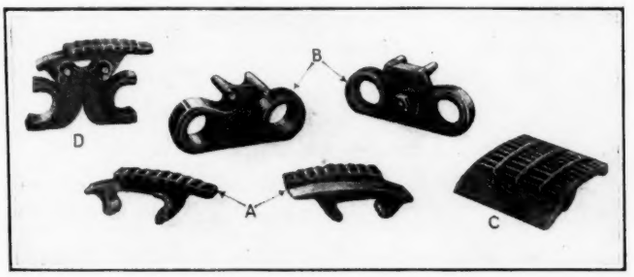


FIG. 3—DETAIL OF GRATE CLIPS AND LINKS

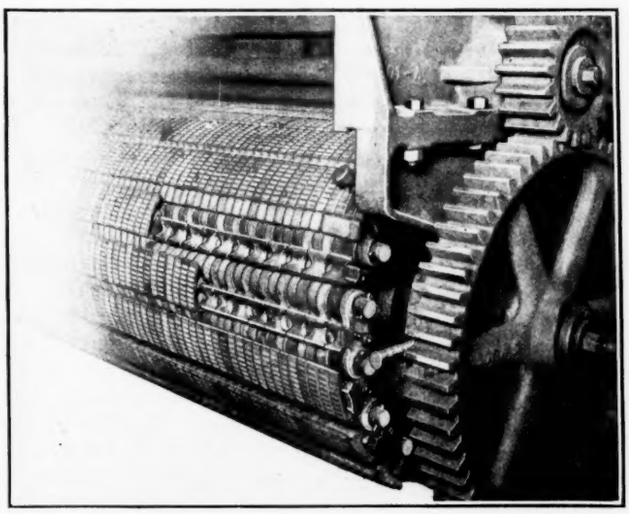


FIG. 4—GRATE CLIPS CAN BE REPLACED WHILE PASSING OVER FRONT SPROCKET

Other special features are the design of the grates and the accessibility for repairs. The details are shown in Fig. 3 and the assembly in Fig. 4. The movable grate consists of top clips *A* forming the fuel grate, and lower links *B* which carry the top clips *A* and receive all the driving stress. This double construction permits the top grate to carry the fuel bed and to be free to expand in any direction without affecting the adjustment of the lower or drive links. In addition, the top grate insulates and protects the lower links from the effects of the furnace heat and the chemical action

of the fuel. It is composed of the small clips *A* which, when assembled, overlap on both sides and at both ends. Sufficient air space is provided where the clips overlap, to permit free passage of air, yet obstructing small particles from falling through the grate. What fuel does sift through the grate is readily reclaimed from the air chamber and returned to the stoker hopper.

The curved top surface of the grate clips tends to insure positive feeding of the fuel in passing underneath the fuel hopper and fuel regulating gate. It also aids materially in the removal of ash and small clinkers at the discharge end of the stoker.

A broken grate clip is readily replaced while passing over the front sprocket (see Fig. 4) by removing the outside grate clip C and slipping on a new clip, moving the other clips toward the center of the grate. This can be done in many cases without stopping or slowing down the regular speed of grate travel. A quick repair link is shown at *D*, Fig. 3. This is made in halves and, when inserted in the space occupied by the broken link, is held in place by the top grate clip.

The stoker is furnished with a pressure water-back as desired and to suit the requirement of the installation.

Some Notes on Power Factor

By L. W. Wyss

The foremost cause of poor power factor is the induction motor, especially when running underloaded. Electric furnaces, induction regulators and transformers also cause poor power factor, but not to so great an extent as induction motors. Rotary converters and synchronous motors operate at power factors depending on their field excitation. When running at unity power factor they are most efficient, and this is where the users will generally endeavor to hold the power factor with this apparatus unless they wish to compensate for the poor power factor of the inductive apparatus in order to prevent being charged extra for poor factor. Rotary converters are not as useful for power-factor correction as synchronous motors, but they can be used to a limited extent. Synchronous motors are frequently designed to operate with leading power factors.

Power systems often have several rotary converters, synchronous-motor generator sets and frequency changers. These should be run at unity power factor unless it is wished to use them as partial synchronous condensers for power-factor correction, which is possible when they are not loaded to their capacity. Operators of this machinery may be careless about keeping the desired power factor unless given definite instructions.

Low system power factor causes poor voltage regulation, heating of conductors with attendant losses. Because of the wattless current flowing in the transmission systems, larger generators, transformers and lines are required to deliver power at low power factor as compared with good power factor. From 0.90 to 1.00 may be considered good power factor, 0.80 to 0.90 is fair and below 0.80 is poor.

A generating station or a group of generating stations may offer some interesting problems relative to how the power factor should be carried on the different generators. The system power factor cannot be changed by any adjustments at generating plants. In other words, given a system that supplies power at 80 per cent lagging, the generators will have to generate power at 80 per cent leading to overcome the lag, since for every unit of wattless current flowing through apparatus causing the lagging power factor there must be a compensating unit produced by leading apparatus. Synchronous generators seldom operate with lagging power factor, but induction generators always do.

Consider the problems involved in generating power for a system at 80 per cent lagging power factor, assuming that the system has no induction generators or synchronous generators operating lagging. If the system composed of either one generating plant or more has generators that are working at economical loads, of course each should operate at 80 per cent leading. On the other hand, for economic reasons it may not be desirable to carry the power factor at 80 per cent, as some generators may be in a position to deliver power at lower power factors, resulting in beneficial conditions to those generators that are enabled to operate at power factors closer to unity.

The next thing to consider is how to adjust the power factor among the several generators as desired. The power factor of a generator can be adjusted by increasing or decreasing the field excitation. If the excitation of a generator is increased, it may work as a partial synchronous condenser when not fully loaded until one of the following limitations is reached: Maximum exciter voltage; complete saturation of generator field poles; maximum amperes or kilovolt-amperes; high exciter voltage, causing excessive sparking of regulator points.

A generator may be favored with power factor near unity by decreasing the field excitation, but care must be taken not to weaken the field so that there is danger of the generator's pulling out of step in the event of a disturbance on the system.

The electrostatic capacity of long high-tension transmission lines is beneficial for power-factor correction, but when such lines are lightly loaded the generators must deliver at lagging wattless current to overcome the leading wattless of the line. In such cases the field excitation of the generators is low, reaching nearly zero in some cases. In so far as practical the transmission of wattless current due to poor power factor should be prevented, as the line loss is thereby increased. A steam plant located near the inductive load should deliver power at leading power factor rather than allow the hydro-electric plant at the end of a long line to do so if there are no other economic problems involved.

On an interconnected system of hydro and steam plants the hydro plants usually run with gates wide open during high-water periods when there is enough load. In such cases the kilovolt-ampere load on the hydro-plant generators may limit their output when the power factor is low. In such cases the remedy lies in increasing the field excitation of the steam-plant generators so that the hydro generators can run at nearer unity power factor and with turbine gates wide open, thus cutting down the coal consumption of the steam plants.

It might be mentioned that in shifting the power factor between plants using Tirrill regulators, it may not be necessary to adjust the field rheostats. The plant on which it is desired to carry the low-power-factor load should have its voltage raised a little, while the plant that is to operate near unity can have its voltage lowered by the usual regulator adjustments. Should the bus voltage at either plant be too high or too low under such operating conditions, perhaps the transformer ratios can be changed to advantage.

Steam Turbine Governors and Valve Gears—Adjusting the Valve Travel*

By EUSTIS H. THOMPSON†

PROPER operation of a valve gear in normal condition depends on three general adjustments: (1) That of valve travel, which causes the valve to move in proper relation to the throw or movement of the governor; (2) governor speed giving correct speed under no-load conditions; (3) speed regulation, which determines the total drop in speed from no-load to full-load, as well as the relation of speed to valve opening through the entire load range.

In addition there are local adjustments of synchronizing springs, dashpots, constructional features, etc., depending on the particular type and design of the gear.

Connecting the valve element to the governor so that the valve will close satisfactorily under no-load conditions, as well as open the necessary amount for overload appears to be a simple matter. A number of factors, however, must be understood and taken into consideration in order to make this adjustment in the most convenient and dependable manner.

The following results of misadjustment may arise in operation: (1) Insufficient valve opening at extreme overload; (2) insufficient closing of the valve element at no load so as to cause overspeeding; (3) satisfactory operation with regard to both these conditions followed by occasional running away or overspeeding at no load; (4) jamming of the gear when in slow-speed position.

It may be most convenient to make the travel adjustment, (1) with the machine shut down, (2) when running at low speed, or (3) at no load, depending on the class and type of valve gear as well as operating conditions.

Manufacturers have their own methods of locating the positions of the various links of the valve gear, so that the travel adjustment can usually be made with the machine shut down or turning over slowly; their instructions should naturally receive first consideration.

The purpose of these articles is to present the principles underlying such adjustments so that the proper procedure may be easily determined without special instructions, while also serving to make the manufacturers' descriptions more readily understood.

There is usually one point for adjusting the series of links between the governor and valve elements such as a connecting rod or turnbuckle, Fig. 2, which may be shortened or lengthened as in the hydraulic gear. Shims are sometimes so provided in thrust bearings that they may be changed easily, as in Fig. 3. It will be seen in Fig. 1 that the governor stem will have a certain amount of movement or travel between the extreme high-speed and low-speed positions of the governor. The lever connected to the valve element will also have a certain amount of travel corresponding to the amount of opening that is possible in the valve element between its extreme positions, as indicated in the dotted lines, Fig. 3.

There are three classes of gears with regard to travel of valve and governor at the point of adjustment: (A) where the extreme travel of the link connected to the valve element, is equal to that of the link-connected to the governor at this point of adjustment; (B) where the travel of the governor produces a smaller amount of movement at the point of adjustment than is possible in the valve element; (C) where the governor travel at this point is greater than is possible in the link connected to the valve element.

In some gears it is necessary to make this adjustment when the machine is shut down, such as in Fig. 3, where thrust-bearing shims must be changed while at rest; while in other gears it is necessary to complete the travel adjustment when the machine is revolving slowly, as in the case of hydraulic gears where oil pressure is necessary and the pumps are geared to the turbine. If the adjusting mechanism can be changed while the machine is running, a third method can be employed of setting the valve at no-load speed, as described later.

THIS series of articles on steam-turbine valve gears deals with the principles of adjustment, the troubles encountered, and methods of locating and correcting them. The material is based principally on first-hand experience, and is therefore limited in comparison with the great field now covered by steam turbines. It is hoped that engineers who design, operate or erect turbine machinery will contribute experiences, ideas or discussions that these articles may suggest. It would be of wide benefit to cover more thoroughly the field of practical operation, about which comparatively little information has been published.

One factor that must always be considered in travel adjustment is the allowance for wear, expansion or other change of link positions. The series of links between the governor and valve element may vary in actual length after being adjusted, especially if the machine is cold when this is done. Expansion and wear may change the adjustment of the valve so as to make it tend to close at either a higher or a lower speed, depending on the design of the gear. If the links should change so as to fail to close the valve at no load, overspeeding would result. The case of overspeed usually occurs in practice so that it is customary to make an allowance when adjusting travel for the certain closing of the valve. This is for the reason, that, in case the change of the links tends to keep the valve from closing at no-load speed, there will still be some reserve governor travel available to complete the closing of the valve, in spite of this change.

A type of gear in which the valve and governor have equal travel at the point of adjustment is indicated in Fig. 1. Here the travel is adjusted by shifting the thrust bearing along the governor stem by means of a clamp nut and push screw.

Suppose that the point D travels $\frac{1}{4}$ in. from closed

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valve position to wide open position. The wide open position is determined by the valve extension *K* contacting with the casing. The closed position brings the valve flanges to rest on the valve seats, as indicated at *C*. The movement of the governor lever at *D* is also ¼ in. from closed to wide open position of the flyballs.

In order to adjust the travel, suppose the clamp nut and push screws are slacked off. With the machine at

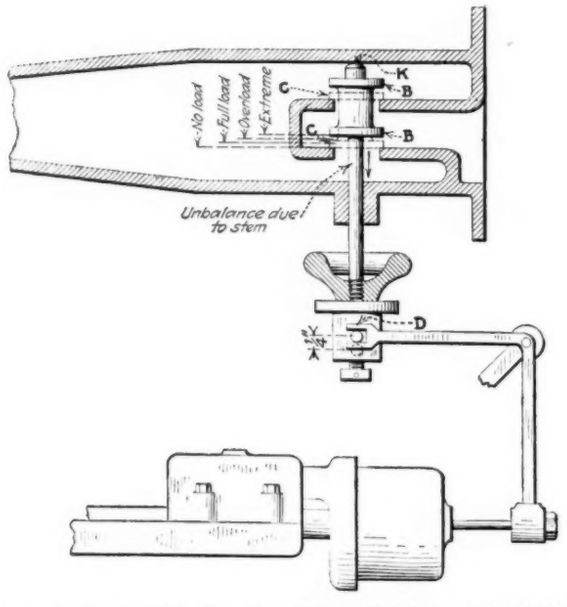


FIG. 1—VALVE TRAVEL MAY BE ADJUSTED WHEN SHUT DOWN OR OPERATING

rest the valve should be in the extreme position of maximum opening, contacting at *K*, and the governor lever should also be in the position holding the valve wide open. Now tighten the clamp nut until the valve is wide open and just touches at *K*. Tighten the push screw to lock the thrust, and the travel is adjusted to give required operation.

Operation would probably be satisfactory for some time. It might happen that expansion inside the valve chest would eventually lengthen the valve stem perhaps 1/32-in. With everything else in the original condition, the valve would now fail to close by 1/32-in. in the high-speed position of the governor, and the turbine would tend to overspeed at no load. In order to secure a safe adjustment, however, it would be wise to allow 1/32 to 3/64 in. for reserve governor travel as before mentioned. Therefore, in adjusting the travel, tighten the clamp nut until the valve is wide open and contacts at *K*. Then slack the clamp nut until an adjustment in the closing direction of 1/32 to 3/64 in. is made. Tighten up the push screw, and a reserve travel for safety is now assured. There will be plenty of valve opening remaining, to carry the overload. This illustration is for explanatory purposes only and does not necessarily apply in detail to any standard make.

CLASS B, WITH GOVERNOR TRAVEL SMALLER THAN VALVE TRAVEL

With the second class (*B*) of valve gears, where the governor travel is less than the possible valve travel, we know that if the valve element is set in its wide open position and connected to the governor, when shut down, while the governor weights are in the low-speed position the governor travel will not be sufficient to close the valve, its travel being less than the valve requires. This simply means that it is often more convenient to construct valves that may open considerably more than necessary, as is usually encountered in commercial gears. In many cases it is possible to locate the exact amount of valve opening required to admit enough steam for the overload position of the governor, as explained in connection with Fig. 1. If the valve is placed in this position, when the turbine is shut down, and a small amount of additional closing adjustment is allowed so as to obtain a small amount of reserve governor travel, the series of links can be set in this position and the valve will then close satisfactorily at no-load speed.

Fig. 2 indicates the usual scheme of hydraulic valve gear to be adjusted by a turnbuckle link connecting the governor lever to the pilot valve. The exact overload valve position can be easily located. This can be adjusted when the turbine is shut down, if an auxiliary oil pump is provided; otherwise, the machine should be turned over by steam until normal oil pressure is generated by the geared pump. It is better for another reason to adjust this at a speed just below that where the flyballs begin to open. Centrifugal forces may make a slight difference in the governor stem length, and revolving at high speed has some effect on the governor lever that is not felt when shut down. An adjustment made at this point will therefore be nearer operating condition when revolving than when shut down.

Adjust the turnbuckle so that the overload valve, which is the first one to close, is just on the point of closing, as at *A*, and any movement of the governor will start its closing stroke. All the governor travel to no load condition will then be available in closing the remaining valves, and all possible excess travel will be

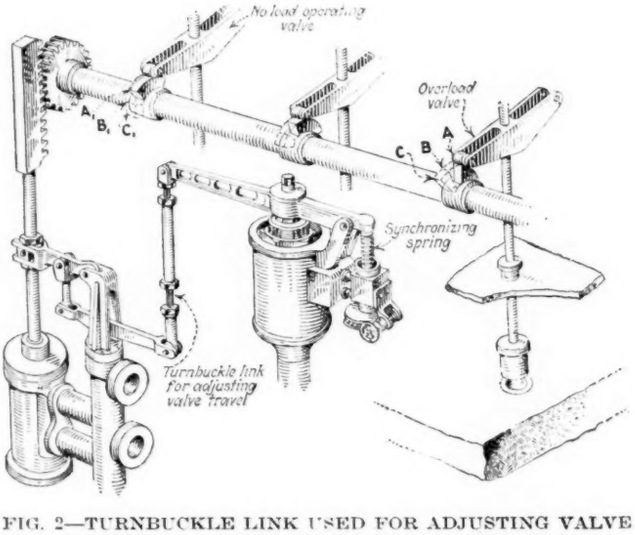


FIG. 2—TURNBUCKLE LINK USED FOR ADJUSTING VALVE TRAVEL IN A HYDRAULIC-TYPE VALVE GEAR

available to close the valves at no load and prevent overspeeding.

The governor travel would ordinarily be sufficient to close all valves if adjusted to bring cams in position *B*. It could not close all valves if adjusted to position *C*; here the turbine would be sure to trip the emergency at no load. To be safe, adjustment is made with cams as at *A*, giving a reserve travel of *A* to *B*, to insure closure at no load. The overload valve position in other forms of gears may require measuring or tramming for definite location.

Fig. 3 shows a direct-connected valve gear. This must be adjusted when the machine is shut down, as the shims in the governor thrust bearing can be changed only with the machine at rest. The travel of the valve is much greater than that of the governor at the point of adjustment, and it is necessary to set the valve so that the governor will be sure to close it. There is nothing on the valve itself or bell-crank lever to locate this position, where it will admit enough steam for the overload condition. The only possible method is to measure the travel of the governor and then set the valve, when the machine is at rest, so that it will close on slightly less than the actual amount of governor travel.

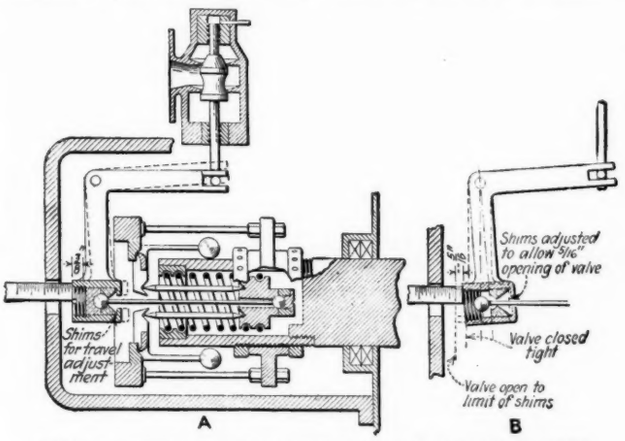


FIG. 3—SHIMS AND SCREW PLUG CHANGE VALVE POSITION WITH RESPECT TO GOVERNOR

In order to measure the governor travel, bring the machine up to speed and measure the movement of the thrust bearing with a rule between open and closed positions of the governor, as indicated at *A* in Fig. 3. It is necessary to overspeed a small amount in order to make sure that the full travel of the governor spindle is being measured. Remove all or a large part of the shims and set up on the screw plug, forcing the thrust bearing over. Then the valve cannot be closed by the governor travel. Watch the speed with a tachometer. The governor balls will move from closed to wide open position, while the distance at each position is measured by the rule at *A*. Suppose this is $\frac{7}{8}$ to $1\frac{1}{4}$ in. giving $\frac{3}{8}$ travel.

When the machine is shut down, remove part of the thrust bearing as at *B*, Fig. 3. Close the valve tightly by pushing in, with the hand, on the bell-crank lever and measure this position as indicated, which we will assume is $1\frac{1}{2}$ in. Now $\frac{1}{32}$ in. allowance for excess travel should ordinarily be sufficient; $\frac{1}{16}$ is better if a light load is carried or there is any tendency, due to valve leakage or lost motion, to run away. We will suppose it is decided to make the latter allowance. Place enough shims in the thrust chamber so that when the bell-crank lever is pulled out against the pressure of the governor stem, it will travel $\frac{1}{16}$ in. Measure this position with a rule. It should be $1\frac{1}{2}$ in., or $1\frac{1}{2}$ less $\frac{1}{16}$, which is $1\frac{15}{16}$ in.

To explain in another way, when we pull the bell-crank lever out against these shims, it will lack $\frac{1}{16}$ travel at this point of closing the valve. The governor can now move $\frac{3}{8}$ at this point from the present low-speed position of the balls to the high-speed "open" ball position. The governor will therefore supply the required $\frac{15}{16}$, to close, with a reserve travel of $\frac{1}{16}$ in. left over.

The travel adjustment of a governor carried on the main turbine shaft may be altered when the shaft position is changed in adjusting blade clearances and also when new parts are installed or the governor speed adjustment altered. Be sure to check travel adjustment after setting clearances of such a machine; it is safer to disconnect the valve before moving the shaft.

Class C, Large Governor and Small Valve Travel

In the third class of valve gears the travel of the governor at the point of adjustment is appreciably greater than the maximum possible travel of the valve element at this point. It is safe with this type to open the valve its full extent when the machine is shut down or revolving slowly, and make the connection at the point of adjustment. Since the governor travel is greater, the valve will be closed under no-load conditions with excess governor travel in reserve.

In Fig. 1, suppose that the valve travel was $\frac{1}{4}$ in. at the point of adjustment, while the governor travel was $\frac{3}{8}$ in. at *D*. Now with adjustment as first described, setting the thrust so that it just contacted, we would have $\frac{1}{8}$ available reserve travel to care for closing the valve.

If, however, the clamp screw is set up too hard, forcing the valve upward, some of the parts may be sprung or broken. Such an adjustment is not likely to be made with the machine at rest, but if anyone changed this adjustment when operating at full speed, it would be easy to reduce reserve closing travel to $\frac{1}{16}$, giving $\frac{1}{16}$ in. excess opening travel, and when the machine is shut down, jam the valve in the overload position, with probable damage. This is a condition that should be guarded against in the third class of valve gears, whether direct acting or hydraulic, especially if adjusting at no load speed.

When the machine is shut down, the valve element may be opened to its widest extent and the connection to the governor made at the point of adjustment with absolute safety in the third class only. In the second class, we must allow for excess governor travel; while in the first class, we must locate the required opening of the valve together with allowance for excess governor travel. Synchronizing springs may tend to change the governor-spindle position. Make travel adjustments with spring in limit of travel tending to open the valve, or raise the speed.

Adjusting the Valve at No-Load Speed

A third method of adjusting the travel (mentioned at the beginning of the article) can be applied to any turbine, whatever class the valve gear falls in, provided the adjusting can be done with the machine running and the valve element does not leak, but is capable of closing tightly. This consists in adjusting the travel with the machine running at no load. The links can be shortened or lengthened until the valve barely closes at no-load speed, and then some additional adjustment given so as to provide excess governor travel, which will result in an absolutely safe adjustment. This may be used as a check on all other methods, provided the overload valve position is checked, to prevent trouble possible in class C gears.

The machine should be brought up to speed and the travel adjustment changed until the turbine will overspeed. It is sometimes convenient to put a field on a generator and locate this overspeed point by the voltage, which will continue to rise after the governor has reached its no-load position. A tachometer can also be used to advantage in the same way. The machine is

held from going more than a reasonable amount above speed, say possibly 3 or 4 per cent by hand throttling. The travel adjustment is now changed so that the valve can just barely close, and on bringing the speed to normal the least change in this adjustment in the other direction would cause overspeed by preventing proper valve closure. A few trials will easily determine this point.

The next step is to give some additional travel adjustment in the closing direction, to provide excess governor travel so that if the governor weights are in the extreme open or high-speed position, the valve element then would be actually somewhat more than closed. This will compensate for wear or expansion in the future.

If the valve element leaks sufficiently to cause the machine to overspeed, this adjustment is more difficult to make. It is then impossible to check overspeeding, and it is necessary to mark the valve element before bringing the turbine up to speed. The position where the valve just closes can be located easily by this method. The valve should be thrown slightly past this position if the governor should reach its extreme high-speed position. With only small valve leaks in a condensing machine it is often possible to make this adjustment satisfactorily by running non-condensing, where the steam leakage will not cause overspeeding.

Where the governor travel exceeds the valve travel, no excessive strains should be placed on the links in the overload position. Increase the excess travel of the no-load position, if necessary. This trouble is explained in connection with class C gears:

Summary

Allow some excess valve adjustment in the closing direction to insure proper valve closure in case the link relations should become disturbed by wear, expansion or other causes.

Supply additional closing adjustment if the governor travel is greater than that of the valve at the point of adjustment. This is for the purpose of preventing jamming of the valve gear when the governor and valve assume extreme low-speed positions.

A quick and sure method of adjusting any gear where the travel relation can be changed while running, is to do this at no-load speed. Check overspeeding and make a safe closing adjustment. Try the low-speed condition and supply additional closing adjustment if there is any tendency to jam.

If a synchronizing spring or other auxiliary device for obtaining small changes of speed is used in the gear, find out which adjustment tends to open the valve or, in other words, gives increase of speed. Make the travel adjustment with this device in the extreme position in this direction.

The valve may be set conveniently when shut down or turning over slowly, if there are means of locating the position of the valve required for maximum load. If no such means are available, the alternative for adjusting when shut down, is to measure the actual governor travel at the point of adjustment. Locate the closed valve position, open it slightly less than the amount of governor movement at the adjusting point, and then secure it to the governor link.

Changes in governor-speed adjustment, regulation or alignment may change the travel adjustment, as well as the installation of new parts, or in cases of governors mounted on turbine shafts, the resetting of blade clearances.

Cylinder Efficiency of an Engine Reveals Avoidable Losses

By W. Turnwald

When examining the efficiency of steam-engine cylinders, it is customary to make comparison with an imaginary engine in which the steam is assumed to do work according to a prescribed cycle. This ideal engine is considered to be perfect in operation as far as heat and other losses are concerned. An example of such a cycle is the one commonly called the Rankine cycle, the peculiarities of which are complete adiabatic expansion from initial to back pressure; that is, no interchange of heat between the steam and the cylinder walls, no clearance, no compression and no heat losses. The term heat losses will be used in the following to include all losses due to heat transfer in any form whatever.

A perfect engine operating on the Rankine cycle with the same initial state of steam and the same back pressure as the actual engine, will consume a certain amount of steam per unit of work. The ratio of this quantity to the steam consumption of the actual engine gives a measure of the efficiency of that engine and is usually

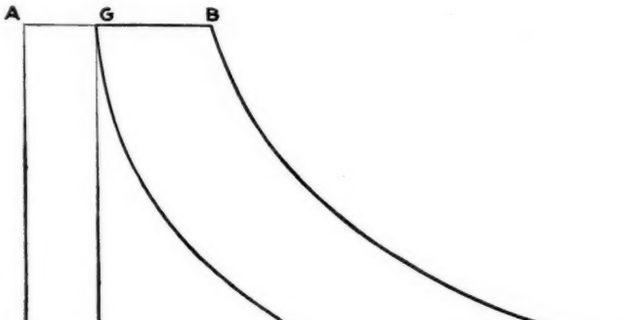


FIG. 1—IDEAL UNAFLOW-ENGINE DIAGRAM

termed the "Rankine cycle ratio." In practice it provides a handy means to estimate the steam consumption to be obtained, provided test results of an engine of similar type are available.

A close study of the basis of the Rankine cycle will reveal the fact that the actual engine will have a different Rankine-cycle ratio for every load, because at heavy loads the cutoff is later, the terminal expansion pressure higher and the loss due to incomplete expansion larger. The Rankine cycle, for given steam conditions has but one water rate and one distinct mean effective pressure co-ordinated, while the actual engine changes its water rate considerably with a change in the mean effective pressure. This is the reason that a comparison on the Rankine-cycle basis does not produce a true picture of the performance of the engine cylinder.

Included in this comparison are losses that are not necessarily chargeable to the engine. Incomplete-expansion loss or clearance-volume loss do not have to be arrived at from test results; anybody skilled in the art and equipped with steam charts and a slide rule is able to calculate the effect of these two items with any desired degree of accuracy. It is the heat losses which reflect the degree of efficiency with which the steam is

utilized in the engine cylinder, and these can be separated from the rest only if the perfect engine, serving as basis of comparison, is charged with the losses due to incomplete expansion and clearance volume.

The difference in steam consumption between the actual engine and the perfect engine operating on the Rankine cycle is due to certain losses which can be grouped under three headings: Heat losses, including

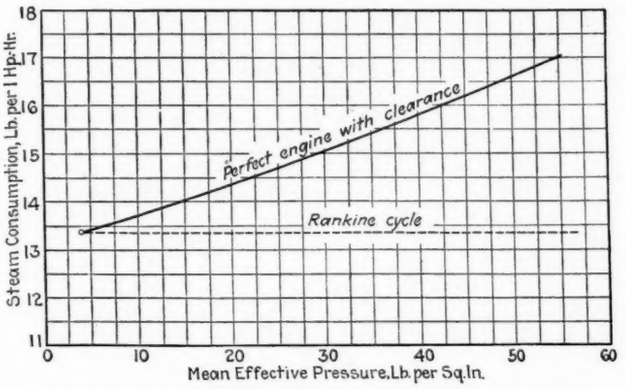


FIG. 2—STEAM CONSUMPTION OF PERFECT ENGINE

losses due to initial condensation, throttling, leakage and radiation; losses due to clearance volume; and losses due to incomplete expansion.

The question is: On what basis should a comparison be made to allow the heat losses to be separated from the rest? The perfect engine evidently would have to be affected with clearance, compression and incomplete expansion. In this case, however, it would also show different mean effective pressures and a distinct water rate for every new mean effective pressure. In the author's opinion, the proper procedure is to assume a perfect engine with adiabatic expansion and compression, the latter of the same length as the compression of the actual engine and a clearance volume proportioned so as to make the terminal compression pressure equal to the initial pressure. The ratio of the steam consumption of this perfect engine to the steam consumption of the actual engine, based on equal mean effective pressures, gives a direct measure of the thermal efficiency of the cylinder, and the proper name for it would be "cylinder efficiency."

The cylinder efficiency clearly reflects the thermal operating condition of the cylinder; it gives a line on how much the heat losses—that is, initial condensation, leakage and throttling—total. It allows one to discern possibilities for improvement and, therefore, should be particularly valuable to engine designers.

Fig. 1 represents the indicator diagram of such an imaginary engine operating on the unaflow principle. It looks very similar to the diagram obtained from an actual unaflow engine except that it has sharp corners. The method employed to find the water rate and mean effective pressure of such an engine is explained in detail in the second edition of Prof. J. Stumpf's book, "*The Unaflow Steam Engine*," in the chapter on clearance volume loss. It will be sufficient here to mention that the principle consists in subdividing the diagram into partial areas which are then calculated by means of the steam chart. As can be seen from Fig. 1, the net area is produced by adding areas *ABCF* and *FCDE* and subtracting area *AGHE*. All these areas may be expressed in either foot-pounds or heat units, and a simple calculation permits one to find the water rate and the mean effective pressure. After several values have been calculated for different terminal expansion pressures, a curve may be plotted as shown in Fig. 2, giving the steam consumption of the perfect engine on a mean effective pressure basis. The lowest point of this curve represents a diagram with complete expansion, and the corresponding steam consumption, therefore, equals that of the engine operating on the Rankine cycle. The vertical distance at any point to the horizontal Rankine-cycle line drawn through the lowest point of the curve, represents the loss due to incomplete expansion and clearance volume.

Plotting the test results of an actual engine, Fig. 3, provides all data necessary to calculate the cylinder efficiency. From the cylinder-efficiency curve of this particular engine it may be concluded that the steam valves were fairly tight, otherwise the high figure of 94 per cent would not be possible.

Another conclusion that can be drawn from this diagram is that the best economy of the engine is obtained at the point where the sum-total of all losses is a minimum. The vertical distance from the steam-consumption curve of the actual engine to the Rankine-cycle line represents the total loss; and it will be observed how the incomplete expansion loss increases with increasing mean effective pressure, while the heat

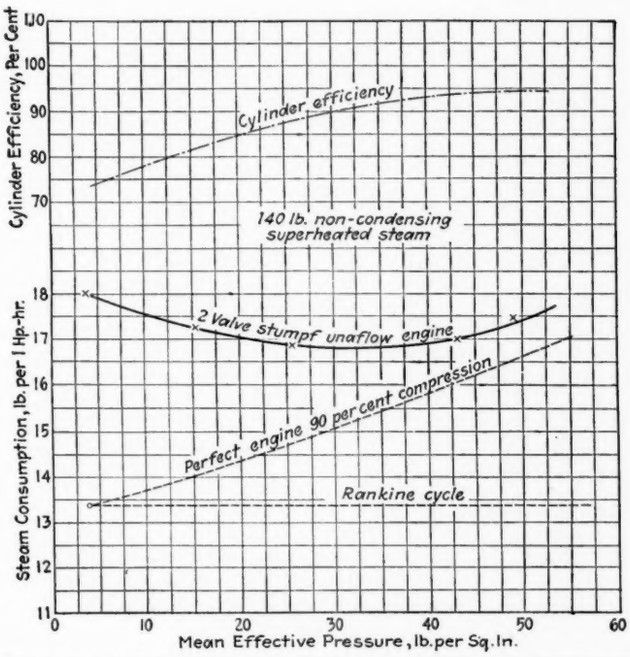

Cylinder Efficiency, Per Cent
Cylinder efficiency
140 lb. non-condensing superheated steam
2 Valve stumpf unaflow engine
Perfect engine 90 per cent compression
Rankine cycle
Steam Consumption, lb. per I Hp-hr.
Mean Effective Pressure, lb. per Sq. In.

FIG. 3—COMPARISON OF ACTUAL AND PERFECT ENGINES

losses at first decrease more rapidly than the former increases. At the point of lowest steam consumption of the actual engine the vertical distance of this curve from the horizontal line is the shortest, therefore the losses are at a minimum. It is also evident that the smaller the heat losses the lower will be the mean effective pressure at which the best steam consumption is obtained. This last conclusion, however, pertains more or less to two-valve unaflow engines only, since the introduction of auxiliary exhaust valves has the effect of moving the Rankine-cycle point of the perfect engine to considerably higher mean effective pressure.

Providence Plant Installs Pulverized-Fuel Equipment

IN THE latter part of 1921 the United Electric Railways, Providence, R. I., made extensive plans for improvements to their generating station, to meet the constantly increasing demand for power. The improvement included also considerable extension to transmission and distribution lines and the building of new substations involving total expenditure of approximately $1,750,000.

The company operates all electric railway lines in Providence and several other cities in that territory, as well as in more than fifteen municipalities.

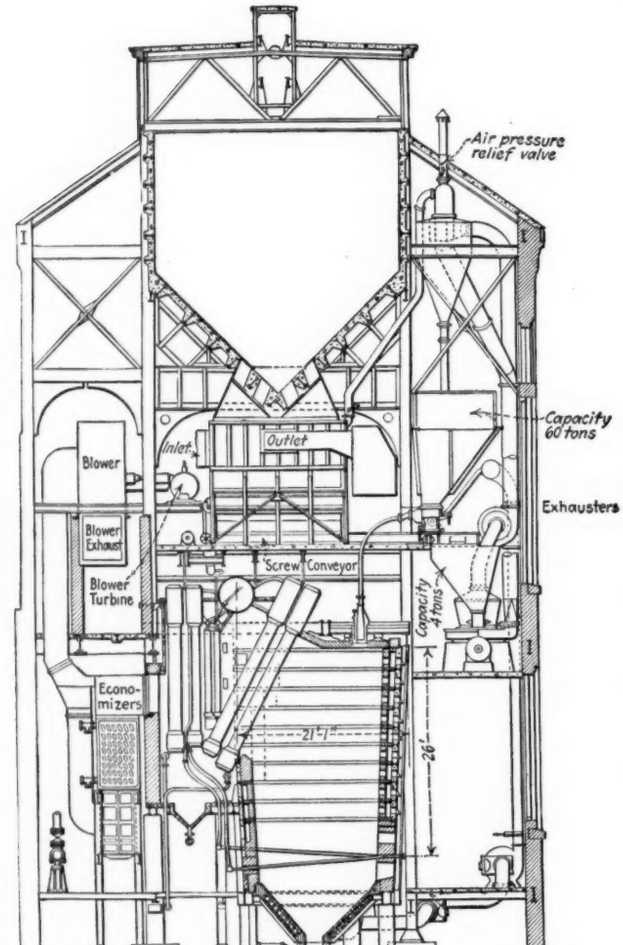


FIG. 1—SECTIONAL ELEVATION OF BOILER PLANT

The extensions to the power plant involved the scrapping of much obsolete equipment, including four old reciprocating engine-driven units, two of 1,500 kw. capacity with alternating-current generators and two of 2,500 kw. capacity with direct-current generators together with their auxiliaries of various kinds; also four 5,200-sq.ft. water-tube boilers with cast-iron headers. These boilers comprised one-quarter of the boiler plant and were arranged in batteries of two on two decks.

The improvements include the installation of an 18,000-kw. General Electric turbine unit with auxiliaries, three 12,666-sq.ft. Bigelow-Hornsby water-tube boilers equipped to burn pulverized coal, together with coal-handling equipment.

The plant as remodeled has been laid out to secure the best results in both capacity and economy with the coal now used with stokers; at the same time the furnace design was arranged so as to permit burning poorer grades of fuel if found economical. Provision has also been made for burning oil in the same furnaces.

A section of the boiler room is shown in Fig. 1, which also shows the arrangement of the boiler auxiliaries and fuel-handling equipment. The boilers are designed for 325 lb., but will operate at approximately 300 lb. at the turbine and a total temperature of 600 deg. Each unit will have eight burners located in the top of the furnace, as shown in Fig. 1. Additional square feet of heating surface is obtained with the water screen in the lower part of the furnace. The screen is divided into sections, each section connected at the one end with the top and the other end with the bottom unit drum of the third row of unit sections of the boiler.

The hopper bottom of the furnace serves as an ashpit. Power-operated gates and a scraper conveyor moving in a trench filled with water are employed in ash handling. Smaller hoppers are provided directly below the bottom unit drums of the boiler to catch the dust deposited at this point.

A Foster steel-tube economizer, having a heating surface two-thirds that of the boiler, is mounted directly back of each unit, taking out the gases at a point about midway of the boiler height.

One of the ruling considerations in the new boiler layout was the shape of the boiler house and the location of the building columns. A vertical or upright type of boiler was selected because it fits conveniently into the building and also lends itself well to the provision of the necessary large combustion space for the burning of pulverized fuel. It was impossible to use any large single-set horizontal-tube boiler of about the same capacity because of building-steel interferences.

The preference was for singly set boilers to avoid the middle wall required with the battery arrangement, and because it was desired to have them accessible all around. With the single setting provision has been made for cooling of the walls with air. As large a boiler as possible was selected that would still leave reasonably ample passage space between units.

The boilers are hung from steel I-beams mounted between the building columns. Where necessary these were reinforced at the bottom with a heavy concrete envelope cast integral with the floor mat. The boiler walls are of steel plate lined first with "silocel" brick carried on horizontal structural steel H-sections attached to the sheet steel about two feet apart. The refractory lining is mounted, at a short distance away, inside the wall, to which it is attached by special firebrick shapes and iron clamps supported by the H-sections.

Between the front and rear sections of the boiler a Foster superheater is mounted. This is connected with the steam drum in such a way that the steam enters at the back of the superheater, giving rise to the term "counter-current" superheater.

The boiler house, having been built high on account of the previous double-deck boiler arrangements, provided sufficient space for installing the entire equipment inside the main boiler-plant building. The original reinforced concrete bunker built close under the roof was retained, but was divided by partitions into three sections in which different kinds of coal can be stored if desired, thus allowing the making of predetermined mixtures at will as the coal is passed by gravity from the bunker through chutes to the driers, of which two are now being installed. One drier is over and between boilers 1 and 2, the other between boilers 2 and 3, and a third will be added when boiler 4 is installed. The drier is divided into two sections, each section discharging into its independent screw conveyor, the two sections being fed from adjoining sections of the bunker. Through the driers will be drawn some of the flue gases after leaving the economizers.

From each drier the fuel will be fed to a pair of pulverizers, which are Raymond mills, from which it will be lifted by an exhaust fan to cyclone separators located above the boilers and adjacent to the coal bunkers, as shown in Fig. 2. Four mills are now being installed, and there is sufficient space for two more mills if required. The separators and pulverized coal bins are so connected that two separators will discharge into two bins and two into three bins by gravity.

From the separators the fuel will fall into bunkers of about 60 tons capacity each from which feeders, driven by Reeves variable-speed motor drives, will convey the coal through pipes to the burners. There are four double feeders to each boiler, each feeding two burners arranged as shown in Fig. 2. Air for the feeders will be supplied from fans installed near the main floor level and drawing their supply through air spaces in the hopper bottoms.

Draft for the furnaces will be furnished by a brick stack 312 ft. high by 16 ft. in diameter, and by 10-ft. induced-draft fans, one for each economizer and boiler. The fans, driven by geared turbines, are mounted in the space behind the boilers and above both the economizers and the main flue. Up to 300 per cent of rating the flue gases will pass through the economizers; for higher ratings they will be bypassed.

The main unit is supplied with Westinghouse-Leblanc twin condensers, designed to provide for operation at high efficiency with different loads on the turbine and to give maximum flexibility in operation. If necessary, one-half of the condenser can carry the load in off-peak hours, and the load during several hours after midnight will require but one-half for best economy.

The auxiliaries for each half of the condenser are driven by a steam turbine. The two halves are set at an angle, the shafts converging so that a motor set in the angle can be connected either to one condenser or the other by turning it on its foundation. This is an operation requiring a comparatively short time.

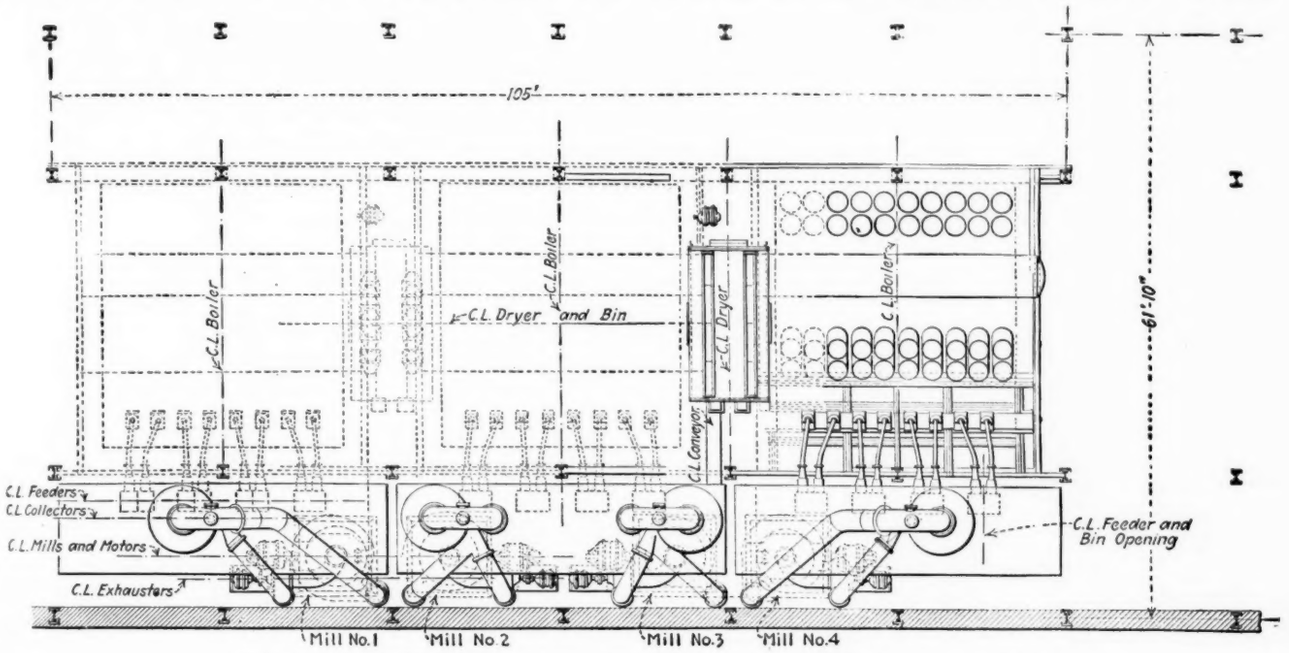


FIG. 2—PLAN OF BOILER-ROOM, SHOWING ARRANGEMENT OF EQUIPMENT

In addition to the work described there are now under way, or otherwise planned for construction in 1923, power-system improvements involving new substations, transmission lines and distribution circuits both overhead and underground, as well as a track circuit block signal system on about eight miles of high-speed road. The task of handling the large amount of additional engineering and construction work required has been met largely by the company's own engineering staff and construction forces, additional men having been employed from time to time as conditions required. W. C. Slade, superintendent of power and lines of the United Electric Railways, is in charge of the power-system changes, while H. W. Sanborn, chief engineer of the company, is in charge of all building and structural-steel work involved. A. S. Davis, assistant superintendent of power and lines, is in immediate charge of the construction work in progress in the generating plant and is being aided by J. C. Millard of the engineering staff.

Apco Unit Pulverized Coal System

A SIMPLE powdered-coal system built at moderate price to serve boilers individually and to pulverize the coal as it is burned, has been designed by the American Pulverizer Company, of St. Louis, Mo. It consists of the pulverizer, a so-called expansion chamber and motor-driven blower units supplying the burners. Where the moisture in the coal exceeds 3 per cent, a tower drier, which may also function as a bunker, utilizing the waste gases of combustion, is desirable. Fig. 1 shows the arrangement of the equipment, including the drier, and the general design of the furnace. In Fig. 2 the preparation plant is shown in more complete detail.

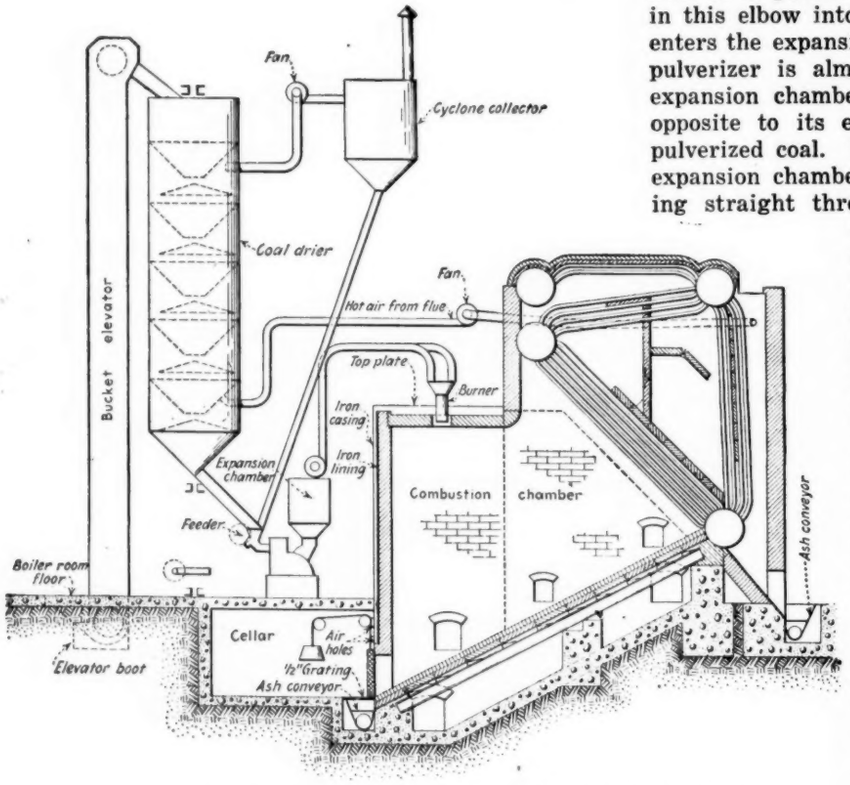


FIG. 1—APCO POWDERED COAL UNIT SYSTEM, INCLUDING DRIER AND ELEVATOR

The pulverizer, which is of the ring type, is motor-driven at a speed of 600 r.p.m. It is supplied with coal, crushed to 1¼ in., or smaller by an eccentric-driven feeder, hand regulated, or if desired by a motor-driven feeder regulated by maximum and minimum solenoids inserted in the supply circuit to the pulverizer motor. Overfeeding loads up the pulverizer, causing a flow of current greater than normal, so that the maximum solenoid functions and stops the feed. When the load has lightened and the flow of current is less, the minimum solenoid starts the feeder.

About 30 per cent of the air required for combustion enters through an inlet in the suction elbow connecting the pulverizer and the expansion chamber. Part of it passes down on one side of a deflection gate in this elbow into the pulverizer, while the remainder enters the expansion chamber. The air drawn into the pulverizer is almost immediately forced up into the expansion chamber at the side of the deflection gate opposite to its entrance, carrying with it the finely pulverized coal. Deflection gates at the outlets to the expansion chamber prevent the coal-air mixture carrying straight through. With the sudden increase of volume upon entrance to the expansion chamber, the velocity of the mixture slows down, dropping the coarser particles of coal that have been carried along with the current or propelling into the chamber by centrifugal action, and allowing them to return to the pulverizer for further grinding through the opening at the inlet side of the deflection gate. At the air inlet a small receptacle is provided to catch and retain the tramp iron that may have been carried through the machine.

From the expansion chamber double-fan units with the driving motor placed between the two fans of a unit, draw the fuel mixture and deliver it through the burners vertically downward into the boiler furnace. Each pair of fans deliver to a single burner, the two delivery lines being brought together in the funnel-shaped top of the burner, where the two streams, of equal velocity and density, meet and produce a swirling action tending to commingle thoroughly the coal dust and the air, so that a uniform mixture is delivered into the furnace at relatively low velocity. The lower end of the burner is shaped to give the proper direction and form to the fuel stream. Because of this low velocity and the premixing of the air and the coal dust,

ESTIMATED EFFICIENCY WITH VARYING ASH AND MOISTURE CONTENTS IN COAL AND COST OF GRINDING

1 Ash, Including Pyrite in Coal, per Cent	2 Power Cost for Ash Grinding Contents, per Cent	3 Increased Grinding Cost Based on Moisture Content, per Cent	4 Moisture in Coal, per Cent	5 Carbon in Ash, by Caused Moisture in Coal, per Cent	6 CO_2 in Chimney Gases, per Cent	7 Loss Indicated by CO_2 Content, per Cent	8 Loss in CO Content, per Cent	9 Stack Loss with 510 Deg. Gases, per Cent	10 Radiation and Unaccounted for Losses, per Cent	11 Total Losses in Boiler, per Cent	12 Boiler Efficiency Based on Losses, per Cent	13 Boiler and Economizer Efficiency, per Cent	14* Gross Efficiency, per Cent	15* Power for Grinding, per Cent	16* Net Efficiency, Grinding Power Deducted, per Cent
6	0.75	— 3	1	0.5	14.5	0.5	1.5	17	5	24.5	75.5	81.5	81.5	1.75	79.75
8	1.00	— 2.25	2	1	14.5	0.5	1	17	5	24.5	75.5	81.5	81.5	2.75	78.75
10	1.25	— 1.5	3	2	14.5	0.5	1.5	17	5	25	75	81.0	81	3.75	77.95
12	1.50	— 0.75	4	3	14	0.8	...	17	5	25.8	74.2	80.2	81.2	4.00	77.20
14	1.75	...	5	4	14	0.8	...	17	5	26.8	73.2	79.2	81.2	4.25	76.95
15	1.875	0.75	6	5	13.5	1.25	...	17	5	28.25	71.75	77.75	80.75	4.375	76.37
16	2.00	1.50	7	6	13	1.75	...	17	5	29.75	70.25	76.25	80.25	4.5	75.75
17	2.125	2.25	8	7	12	2.8	...	17	5	31.8	68.2	74.2	79.2	4.625	74.57
18	2.25	+ 3.05	9	7.5	10	5.7	...	17	5	35.2	65.8	71.8	77.3	4.75	72.55
19	2.75	+ 3.75	10	8	8	9.6	...	17	5	39.6	60.4	66.4	72.4	5.25	67.15

* Based on maximum of 3 per cent moisture in coal.

a special hot zone is formed about ten inches below the mouth of the burner. All particles of dust must pass through this zone and in doing so are expanded and disintegrated, to be brought into contact with the necessary amount of air.

It will be remembered that about 30 per cent of the air needed for complete combustion is premixed with the pulverized coal. Additional air enters around the burners and through the ash door, and the rest is drawn through the bricks of the furnace walls. By a special process these brick are made more porous than usual. The air passing through the brick tends to keep them cool so that the practice is to lay up only a 9-in. wall extending out from the boiler side walls in the form of a semicircle. With the boiler in full operation the external surface of this wall is barely warm, showing that there is little loss by radiation. An iron casing, with an air space between it and the brick, incloses this wall.

It should be explained that with a boiler of 4,000 sq.ft. or larger, the practice will be to install three burners and therefore three fan units, one being operated to produce nominal rating, two burners and two fan units to give double this output and three units to force the boiler to 300 per cent of rating or better.

The deflection gates also serve as valves that may be regulated to vary the flow. They are in goosenecks, Fig. 2, and at the side is an air bypass through which more or less air admitted directly to the fan determines the degree of vacuum in the expansion chamber.

stationary to retain high-moisture coal for a comparatively longer period.

While the disks are cone-shaped, the slope is well within the angle of repose of the coal, so that scrapers attached to the shell must remove it before it passes on down to the next disk and finally out to the pulverizer feeder. Spreading the coal out in this way brings it into intimate contact with the hot gases of combustion which enter at the bottom of the tower and pass up through the coal and through perforations in the guide

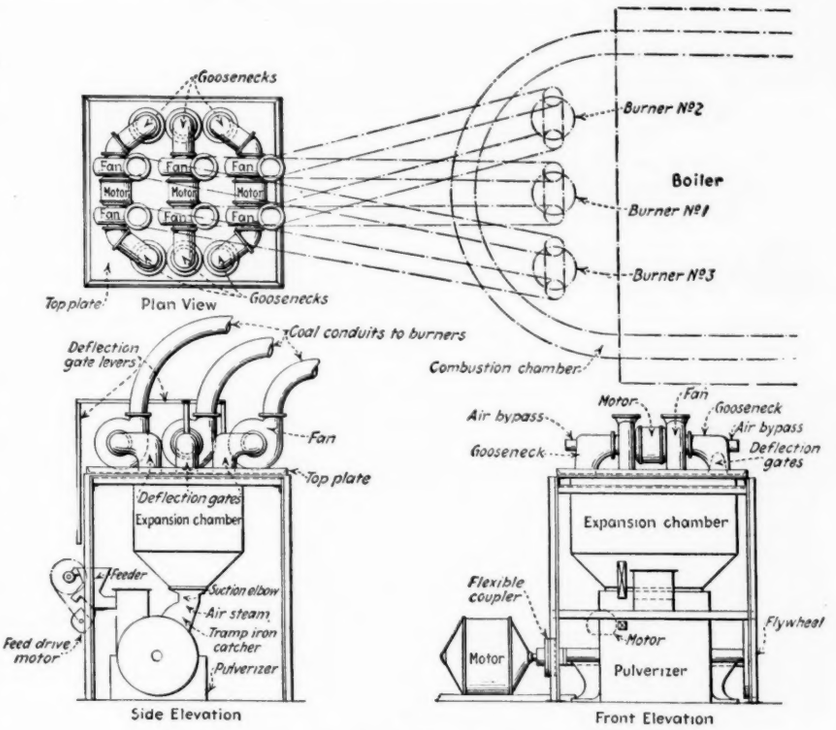


FIG. 2—DETAILS OF COAL PREPARATION EQUIPMENT

Reference to Fig. 1 will show that the furnace has a sloping bottom which is air-cooled and arranged so that ash and slag will drop to this floor and roll down the incline through the ash door at the bottom, the opening of which is varied to maintain a definite percentage of CO_2. It is claimed that the heavier particles of carbon that may drop with the ash are burned on the furnace floor and any lighter particles that approach the ash door are carried back by the entering current of air, to be consumed in the furnace.

Experience with the equipment just described has shown that if trouble is to be avoided, the coal entering the pulverizer should not contain moisture much above 3 per cent. Higher moisture content requires more grinding power and will prevent fine grinding, if it does not clog the pulverizer. Coarse coal means a heavy ashpit loss and, as a result of this, the efficiency is lowered.

As a consequence coals of the Middle West will require drying, and for this purpose a simple form of tower drier, which may also function as a bunker to hold the crushed coal, has been designed. It is made up of a cylindrical shell measuring about 40 ft. to the top, which is the usual elevation of the average overhead bunker. Within the shell is a series of hopper bottom guides alternating with low cone-shaped disks, the latter being secured to a common vertical shaft which may be rotated at the desired speed or held

plates. At the top of the drier a second fan draws off the gases, making delivery to a cyclone collector which returns any fine coal that may have carried over, to the feeder, and vents the gases to atmosphere. The drier will store about 15 tons of coal and, depending upon the moisture content, will dry 3 to 5 tons an hour.

From continued experience with the equipment the company has prepared the accompanying table to indicate probable efficiencies with varying percentages of ash and moisture in the coal. Other interesting data are the costs of grinding, which range from 1.75 to 5.25 per cent of the power developed. With bituminous coal containing 6 per cent ash the guarantee for wear and tear is given at 5c. per ton and ½c. more for each 1 per cent increase in ash. Column 2 in the table, giving the power cost of grinding the ash, indicates the desirability of burning clean coal.

To eliminate as much as possible the infiltration of air through a boiler setting, one should assume that every crack in the setting is conducting air to the heating surface. Frequent testing for air leaks should also be made around I-beams, stays, tube blower openings and door frames, also along the drum at the top. These points are seldom airtight for any length of time owing to expansion and contraction of the boiler setting. If the setting is whitewashed, the leaks may be seen by the accumulation of dust around the openings.

Engineering on the Caribbean

By M. M. Brown

Some years ago I was employed by a firm of engine builders in New York as a sort of utility man, with the understanding that if I qualified, I would be promoted to the regular staff of erecting engineers. An engine had been sold to a sugar planter named Gonzales, who owned and operated a plantation and mill on the island of Los Baños, just south of Cuba. I had just returned to the office from Newburg, where I had been doctoring a sick engine, and as none of the regular erecting men was available at the time, I was given brief instructions and ordered to sail that afternoon on the same ship that carried the engine.

Señor Gonzales, the planter, was also a passenger, so during the voyage I made his acquaintance and learned from him considerable about the plant. I was determined to show speed on this job, hoping that by so doing I would further my prospects of promotion, and was somewhat dismayed to learn that I must remove the old engine that was there before I could erect the new one; but the owner told me that he had plenty of competent help.

Arriving at the port of debarkation, the engine parts and tools were soon loaded on a lighter. I accompanied Señor Gonzales to the island (eight miles) in a steam launch, and we walked the half-mile to the mill, where, having other business, he left me. Approaching a group of nondescript looking individuals sitting on the ground in the shade of a tree, I inquired where I might find the engineer. One of the men leisurely arose and came toward me; he was tall, barefooted, and wore a ragged shirt and overalls and a straw hat with a peaked crown fully eighteen inches high, which made him appear a giant. "Mi jefe maquinista" (chief engineer), he answered. Not understanding Spanish myself, our

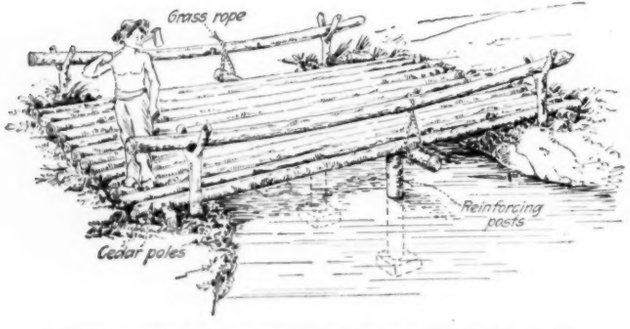


FIG. 1—BRIDGE CONSTRUCTED OF POLES AND SUSPENDED BY GRASS ROPES

conversation was carried on with difficulty. He showed me about the plant, consisting of two 60-in. by 16-ft. horizontal-tubular boilers, their fronts covered with rust. On the safety-valve lever of one, in addition to the regular weight, hung a four-quart pail full of bolts and nuts. On the other, in place of the weight, were two 8-in. pipe flanges. The pointer of one steam gage lay loose at the bottom of the dial. The gage glasses on both water columns were missing, and the bottom gage cocks of both boilers were broken. The engine (a slide-valve of English make) was a wreck; the connecting-rod was bent and one-half of the head end of the cylinder flange, and all the bolts were torn out and the head itself was in several pieces. Upon inquiring the cause of the wreck, Miguel (the chief) said: "Me no savvy, maybe agua" (water).

I started with ten natives the next morning to get the engine from the wharf. Two teams of oxen hitched to two-wheeled carts, such as were used for hauling cane from the fields, had been sent down to haul the engine parts to the mill. The engine was a 16 x 32 Corliss; the wheel was 10 ft. in diameter, 26-in. face, and in two halves, so of course there was nothing that could go in the carts except the tool-chest and boxes containing the valve gear, etc. Skids were made and with both yokes of oxen, an occasional roller, and men with pry-

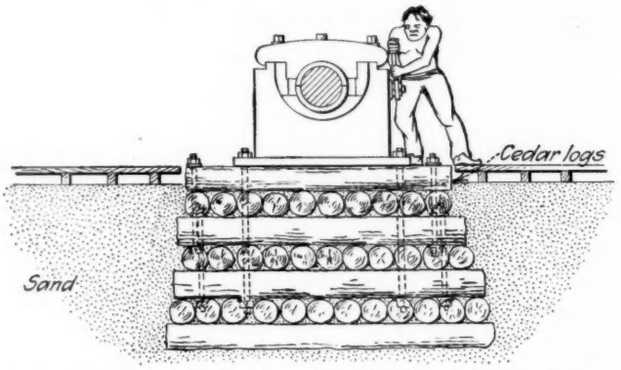


FIG. 2—FOUNDATION OF COB-WORK OF LOGS, FILLED WITH SAND

bars, the parts were moved to a point where a stream had to be crossed. Before we could go farther, the bridge had to be strengthened. After some argument with Miguel and his gang, three 6-in. uprights were set in the brook (as illustrated in Fig. 1) and wedged tightly under the middle timber. This "suspension" bridge was built of cedar poles, hung from large poles by grass ropes, the large poles supported on crotched posts driven in the ground. I was doubtful of the bridge even after the reinforcement, but we got by with it.

When the old engine was dismantled, we began to pull out the foundation, a cob-work of cedar logs. I was surprised to find so little sign of decay in them, after being embedded in the sand for eighteen years. We took out the logs only to about four feet down. Then we made a templet and located the bolt holes, and bored that layer of logs; after placing the bolts, they were supported by the templet, hung from the beams by ropes; each layer of logs was well tamped with sand. Never having had any experience with log foundations, I decided to bolt at the corners as shown.

The new engine was moved into place and leveled up with wedges, the parts assembled and connected up and the engine made ready to run. It was too early in the season to grind cane, but steam was raised on one of the crazy looking boilers (I believe every seam and rivet on it leaked) and I ran for ten hours with a friction load only.

Señor Gonzales seemed pleased with the operation of the engine and gave me an O.K. on the job. I returned to the New York office, expecting my job had "gone fluey," and I had studied up a few excuses to hand them, but I was saluted with instructions to prepare to go to Mexico the following week. But I had had enough of the Tropics and men of the brown skin. In two days I had found an operating job in the city, and I have been satisfied to remain in God's country ever since.

EDITORIALS

F. R. LOW, EDITOR

The Delaware and Hudson Company

THE completion of a century of corporate existence by the Delaware and Hudson Company, celebrated by a dinner at the Hotel Astor on Monday evening, April 23, invites a glance backward at those times when a new country was confronting the problems of intercommunication and a dawning age of industry was groping for motive power and transportation.

The producer of anything for other than local consumption could not locate beyond trucking distance from navigable water. The Erie canal was under construction. There were some railways in use in the coal mines of England, with horses for their motive power. Watt had completed his labors and gone to rest less than four years before. Trevithick had mounted one of his "puffers" on wheels in 1804, and run it upon a track to win a bet of five hundred guineas for the proprietor of the Pen-y-darren Iron Works where the experiment was made, but failed to win the bigger prize of the successful development and adoption of his idea.

At the time of the organization of the Delaware and Hudson Company, the struggle between steam and muscle was still on, and it was not until six years afterward that Stevenson's "Rocket" established, at Rainhill, the superiority of the steam-driven locomotive over the horse as a tractive power.

This company imported the first locomotives that came to America, and it is a demonstration of the courage and vision of engineers like Benjamin Wright, John B. Jervis and Horatio Allen, and of the directors who backed their judgment, that these locomotives were ordered before the decisive Rainhill demonstration.

It is difficult to imagine what this country would have been without the railway system that has grown out of these beginnings and the power that the steam engine in other forms has afforded to its industries; and it is a subject for congratulation that this organization, so active in the inception of this vast development, should have grown with it and persists as one of the roots back into the past, of which our feverish and changeable America has too few.

Within the License Law

SEVERAL letters have been received from readers who, as chief engineers or other responsible heads of large power plants, have sought information as to their present status under the New York State law for licensing professional engineers.

There is room for differences of opinion as to the necessity for the enactment of the law and its effectiveness in safeguarding life, health and property, and that it was permitted to pass two years ago in its present form was largely because of the general apathy on the part of several engineering bodies most directly affected. But whether or not one approves the law, the fact remains that it carries a penalty of from one to five hundred dollars for failure to make application before May 5 of this year if one comes within its scope and continues to practice one's profession after that date. It was a realization of the possible effect of this penalty clause that recently awakened interest on the part of many engineers. As a result some weeks ago a committee was appointed by some of the engineering societies to seek a postponement of the date of enforcement until such time as a more careful study could be made. As a result of the committee's efforts Senator Ferris introduced a bill postponing the date to August 1. The Ferris bill passed the State Senate on April 24 and is now before the Rules Committee of the Assembly. There is a strong likelihood that it may pass that body before final adjournment on May 4.

The wording of the law is general and is not at all specific as to the power-plant field. It was undoubtedly intended primarily to cover surveyors and consulting engineers, and it defines the professional engineer as one who does the planning, designing, constructing, inspecting and supervising of engineering work or appliances involved in public or private projects or in the making of investigations for proposed engineering subjects. From this definition of the professional engineer it would appear that the operating engineer would be little concerned; he is covered by local license laws. But the chief engineer, superintendent of power, or whatever his title may be, of a power plant or system, is not only responsible for the operation, but often to a greater or less extent for the planning, designing and supervision of equipment going into the plant and for the laying down of operating practices. This might easily be construed as placing him within the meaning of the present law.

We are not at all sure that the Licensing Board itself has a very definite opinion as concerns the law's application to this class, but one of the members of the Board who was recently consulted on this point by an editor of *Power*, advised that it would be well for one holding such a position to file his application, and his status then could be determined by the Board according to his specific duties and his qualifications.

Why Pay the Piper?

BUSINESS demands that the purchase of large power units be based principally on thermal economy. Too often, reliability is not recognized as a marketable product. It may be required as a necessary element or taken for granted on the assurance of the sales representative. Mechanical features that appeal to the operating engineer, are often given consideration when no extra cost is involved, but the suggestion of an added investment for further insuring reliability, is often much out of place, when a sales contract is being consummated.

With well-standardized products which have been produced without appreciable alterations over a long interval, such an attitude is justifiable. Large power-house units, however, are subject to continual changes

in design to meet the growing demand for increased thermal efficiency. Improvements relating to reliability have, in a sense, less commercial importance. The experience attendant on building a well-standardized line of machinery is here lacking. New designs must conform to a strict economy of material and workmanship, in order to keep the price per kilowatt at a low figure.

Defects causing outages in prime movers built during the war period and post-war period have been well remedied. Although the public naturally paid for lack of reliability in the long run, strange to say, from present indications the public does not appear to be immediately responsible for the trouble. Public-service corporations, at least in many instances, are well able to secure capital for enlargements. With the demand for improvement to secure increased service continuity, better results will undoubtedly come; nevertheless, reliability has not received the consideration it deserves on a dollars and cents basis. Greater dependability is a good argument for improvements by the manufacturer, but is much less effective as a sales reason for a higher initial cost.

Now, the larger plants are being subjected to an era of radical change both in fuel and steam conditions. Experiments will undoubtedly be conducted with due caution. Why base values entirely on thermal efficiency? Reliability has a high unit value. It is becoming higher as power systems increase. Engineers are certainly capable of distinguishing between the demand of fuel economy and that of service continuity and of assigning a definite relative value to each factor.

It is not in the present-day spirit to hesitate; advancement is imperative. The need, however, of caution on a more positive and scientific scale is apparent. Engineering analyses of distribution and effects of temperature, pressure, expansion and other factors could be applied to advantage. A carefully worked out list of possible emergency conditions, their effects and remedies in terms of dollars, if necessary, would be a useful guidance. We can remedy the faults developed in the past, but radically new conditions present a new series of possibilities. It is highly desirable to avoid future mistakes—and much cheaper, when possible. The price of the shutdown is becoming greater. Why not make better and more liberal provision in the first place to avoid such embarrassments, rather than learn through shortcomings of policy?

Forestalling the Emergency

TO WHAT extent are those who operate power plants warranted in keeping a stock of repair parts on hand? In the long run the greater portion of such parts will be used, so that practically the only cost is the interest on the money invested. This must be increased somewhat by the item of obsolescence which will occasionally enter in where spare parts purchased for an old piece of apparatus are rendered worthless by the installation of more modern equipment. On the other hand, a deduction may be made for the saving in first cost and delivery charges where parts are ordered in fair quantities by freight, rather than one at a time by express. The express item alone is of considerable importance in the case of bulky cast-iron parts, as of stokers for example.

Obviously, this whole question is a matter of insurance. The premium that can economically be paid for such insurance in any particular case depends in the main on the following factors: (1) Probability of such repairs being needed, (2) cost of parts, (3) time required to get them on a rush order, (4) probable cost (in damaged prestige, loss of production, overtime labor, excessive fuel costs, etc.) if parts are not ordered until emergency arises.

The time to think of these things is before the emergency arises. An element of chance enters into all practical affairs, but the good engineer, like the good business man, considers the possibilities and uses his best judgment as to the amount of money and effort that may profitably be spent in forestalling trouble.

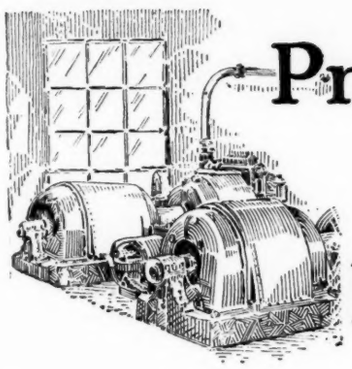
If the engineer, or perhaps the purchasing agent, believes that it would not pay to carry certain spare parts, he should be able to back up his opinion with definite facts and figures, showing just where parts could be obtained in an emergency, how soon they could be delivered on the job, what the total increase in delivered cost would be, whether the absence of such parts would mean a shutdown, and if so what the duration and total cost of such a shutdown would be.

In the case of smaller parts, particularly those that are normally subject to wear, there is usually little excuse for being unprepared. A bad example of unpreparedness in this respect recently occurred in a European isolated plant far from sources of supply. There the failure to provide spare brushes for a rotary converter resulted in the costly shutdown of a large manufacturing plant.

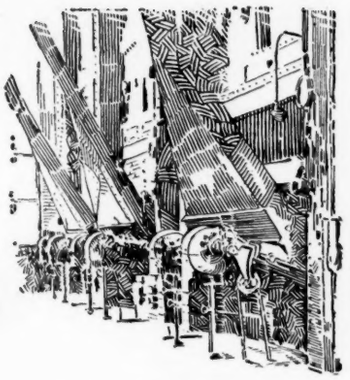
To make certain that all necessary parts are constantly on hand and at the same time to avoid unnecessary tying up of capital in an excess of them, it is important that the engineer keep some sort of a record showing just what is in stock. He may with advantage go a step farther and adopt the system—found invaluable in many manufacturing plants—of having a definitely predetermined minimum stock of each kind of repair part, so that a replenishing order is placed as a matter of routine whenever the stock falls below this minimum. Not only should a record be kept of the stock on hand, but the stock itself should be neatly stored in a systematic manner so that the records can be quickly checked by an inspection of the stockroom shelves and (more important still) so that the parts can be found without the slightest delay when the emergency arises.

To sum up, the matter of spare parts should be the subject of a definite policy, carefully worked out before the emergency arrives.

The Federal Coal Commission's invitation for information has evidently been taken advantage of by both sides in the controversy in the coal industry. Smoke screens have been loosed by eminent counselors, and there is apprehension that the constructive suggestions which each factor in the industry is pledged to bring forward will be lost in the cloud of smoke created for the benefit of the gallery. If the two sides of the industry have no suggestions and if they can offer no solution for the existing intolerable relationship, it is certain that the Commission would welcome a frank acknowledgment to that effect. In such an impasse the government, as a representative of the public, will have to try its hand in an effort to bring about a better functioning of the industry. The coal industry is one in which the public is vitally interested, and there must come an end to trying to put the other fellow in the hole. Instead, we must have peace and industry.

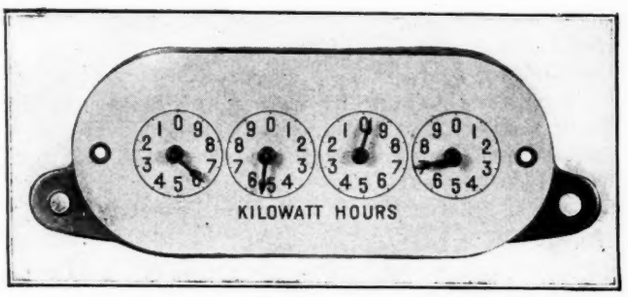


Practical Ideas *from* Practical Men



Hints on the Watt-Hour Meter

The calibrating or test constant of a watt-hour meter is usually stated in terms of watt-seconds or watt-hours. If in watt-seconds it may be reduced to watt-hours by dividing by 3,600, the number of seconds in an hour; if in watt-hours it may be changed to watt-seconds by multiplying by 3,600. Since the meter is calibrated to register a definite amount of energy for each revolution



REGISTER OF A KILOWATT-HOUR METER

of its disk, it is only necessary to provide some means to count these revolutions in terms of kilowatt-hours to measure the power that is transmitted in a certain period.

The prefix kilo means 1,000, therefore a kilowatt-hour is 1,000 watt-hours; the equivalent of one watt for 1,000 hours or 1,000 watts for one hour. To make the first dial hand, on the right in the figure, whose path is divided into 10 divisions, read in kilowatt-hours, there must be a gear in train to make the desired change in units represented by the revolutions of the revolving element in the meter. For example, in a 10-ampere 100-volt Westinghouse type OA meter, one revolution of the disk is equal to $\frac{2}{3}$ of a watt-hour. Since one revolution of the disk shaft represents $\frac{2}{3}$ of a watt-hour and the first dial registers 10 kw.-hr., or 10,000 watt-hours for one revolution of the pointer, a gear ratio of $10{,}000 \div \frac{2}{3} = 15{,}000$ is required between the disk shaft and pointer shaft, and this value is known as the gear ratio of the meter.

The register ratio is the number of revolutions required to be made by the wheel meshing with the worm on the disk shaft, to cause the first dial hand to make one revolution. To find this value, it is only necessary to divide the gear ratio by the gear constant, which is the ratio between the disk-shaft worm and gear with which it meshes, and is always the same for any given make and type of meter regardless of capacity. In the case of the Westinghouse type OA, it is 6¼; in the General Electric, all types, it is 100; Sangamo, 50; Duncan 100. To find the register ratio of the 10-ampere 100-volt type OA meter, it is only necessary to divide the gear ratio, 15,000, by 6¼, which equals 2,400, the value marked on the back of the register.

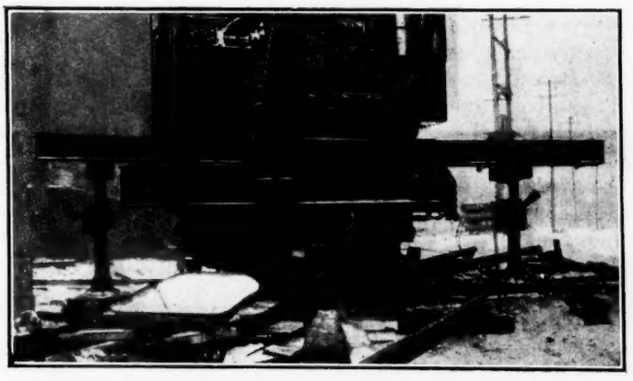
Savannah, Ga. MALCOLM MCKENZIE.

Making a Right-Angle Turn with a Locomotive Crane

A short time ago we were moving a fifty-ton electric locomotive crane from one part of the works to another, and en route it was necessary to make a right-angle turn, changing at this point from a temporary track to a permanent siding.

The temporary track was laid across the siding and the crane placed over the center of the permanent track. A jack was placed under the rear portion of the cab, which was raised about four inches and a crib of ties placed to hold it there; then the jack was removed for use at the other end of the machine.

Three 9-in. I-beams 18 ft. long were available. They were clamped together with suitable bars and $\frac{5}{8}$-in. bolts, clamps being placed at four points along the beams. This being done, the beams were placed under the boom supports and they projected well outside the



CRANE WAS SUPPORTED ON JACKS AND THE TRUCK REVOLVED BY TURNING MOTOR SHAFT BY HAND

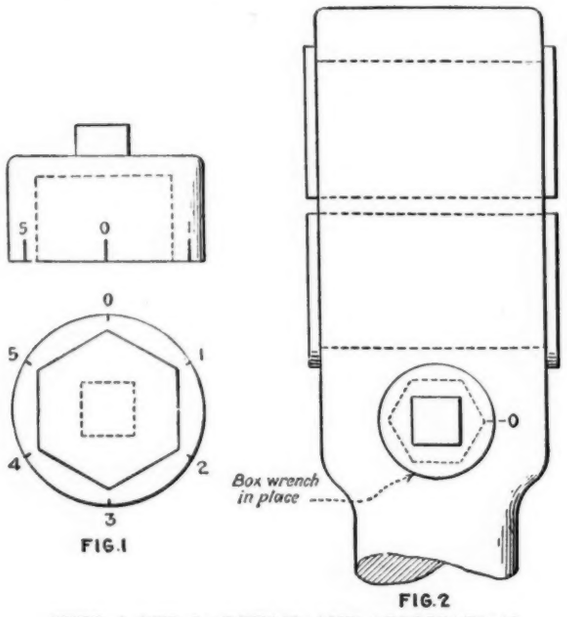
circle of the tracks. A 35-ton jack was placed under each end of the beams, as shown in the illustration. With this arrangement the crane was raised six inches above the track and the temporary track removed. By closing the swinging clutch and rotating the motor shaft with a wrench by hand, the truck was turned one-quarter turn and let down on the permanent track.

Fort Dodge, Iowa. S. C. PAGE.

A Practical Type of Wrench for Adjusting Bearing

The accompanying sketch of a box wrench and its method of use in keying our large vertical engine may prove of interest to *Power* readers.

The location of the wedge bolts on the crosshead end of the rods is such that it necessitates the use of a box



FIGS. 1 AND 2—DETAIL AND APPLICATION OF BOX WRENCH

wrench, and although the crankpin bolts are more accessible, the same wrench is used in keying them.

Fig. 1 shows the method of marking and numbering the box wrench with a line of white paint on its circumference opposite each of the six corners. Fig. 2 shows the rod end with the wrench in position to key up the pin, the operation being as follows: The wrench is placed on the "take-up" end of the wedge bolt with the "zero" corner in view, and a chalk mark is placed on the strap in line with the "zero" corner of the wrench, as denoted by the white "zero line."

A similar wrench is placed on the loosening end of wedge bolt, and the nut is backed off one or more complete turns, the tightening wrench being held at "zero" during this operation. The wrench is now turned and the wedge pulled in as far as it will go.

A comparison of the zero mark on the box wrench and the zero mark on the strap will now show how slack the brasses are in terms of "corners," and as each wrench corner represents a sixth of a turn, it is easy to tell how many turns or fractions of a turn the wedge is slack. The wrench is now turned back to zero, then pulled up the desired amount.

A record of the fractions of a turn required to draw the wedge from the position in which it is left to the tight position, is made each time the bearings are keyed up, and once the proper point for quiet and cool running is established for each bearing, keying up becomes a matter of certainty instead of guesswork.

The crankpins on which these wrenches are used are 8 and 10 in. in diameter and are running from $\frac{1}{4}$ to $\frac{1}{2}$ turn slack, the wedge bolt being about $1\frac{1}{4}$ in. in diameter.

C. B. HUDSON.

North Plymouth, Mass.

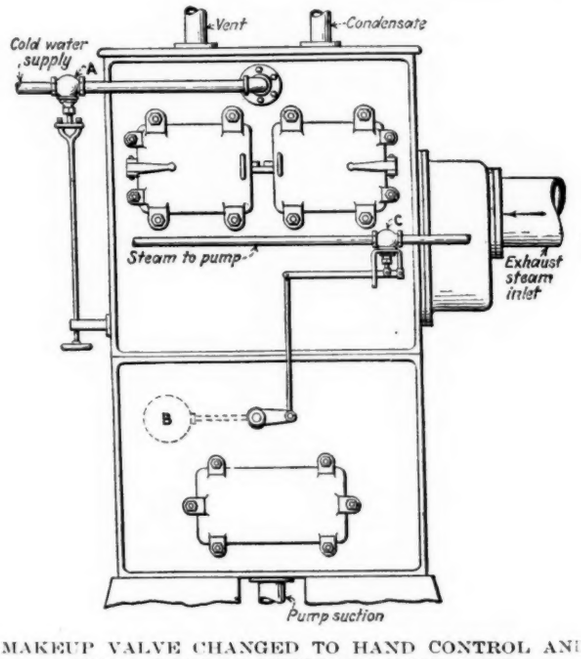
An Improvised Feed-Water Regulator

All engineers and most firemen know that considerable fuel is wasted if the water level in the boiler is allowed to fluctuate to any extent. Yet this condition prevails in nearly every plant not equipped with a feed-water regulator.

When no regulator is in use, if the load on the engine builds up, more water is evaporated from the boiler and passes through the engine and condenser back to the heater, which soon fills to the overflow and goes to waste. The fireman is busy making steam for the increased demand and does not think to speed up the pump a little to take care of the increased volume of water coming back to the heater until he notices the water getting low in the gage glass. And by that time a considerable amount of water that is free from scale-forming solids and at a temperature around 212 deg. has been lost through the heater overflow.

Now when the fireman sees the water getting low in the boiler, he speeds up the pump enough to raise it again, which soon lowers the water in the heater enough to open the float valve in the makeup line. This volume of cold water absorbs all the heat in the exhaust steam, and unless there is an excess of steam, the temperature of the water in the heater is lowered until the pump is slowed down again.

To correct this difficulty without the expense of buying a regulator, we changed the makeup valve *A* to hand control and connected the float *B* to a throttle valve *C* in the steam line to the pump, as shown in the cut. This has resulted in a uniform water level being



MAKEUP VALVE CHANGED TO HAND CONTROL AND FLOAT USED TO REGULATE FEED PUMP

maintained in the boiler and a uniform temperature in the heater, and no condensate is allowed to go to waste.

When more or less water is needed in the boiler, the fireman has only to change the hand control valve in the makeup line, being careful to make only gradual changes so as not to lower the temperature in the heater or allow exhaust steam to go to waste.

Ft. Myers, Fla. R. G. TRUEBGER.

Comments from Readers

What Causes Tubes To Blister with Oil Burning?

Referring to the inquiry of C. W. Hill in the March 27 issue, "What causes the tubes to blister with oil burning," the trouble is undoubtedly due to the restriction of the gases at the point indicated. Since the boilers were originally installed for waste heat from open-hearth furnaces, they no doubt were baffled accordingly, but now, being direct oil fired, there is a much larger gas volume and higher temperature. I would suggest lowering the baffle at the first pass which would create a better gas circulation.

There are, of course, other causes of tubes blistering, but from my experience furnace design is most important. It seems to me that the oil pressure of 110 lb. is unnecessarily high. I have had excellent results with a pressure of only 20 lb. at the burner.

Lima, Ohio. W. F. SCHAREZLIN.

With the high pressures which Mr. Hill is using on both oil and steam, the conditions are favorable for carbonizing at the burner tip, and undoubtedly this is occurring, giving a blast or torch effect, with the resulting trouble.

It is apparent from the illustration that the trouble begins and extends above the point just over the bridge wall, approximately in line with the burner. With the proper burner and correct conditions of oil and steam pressures and temperatures, the bridge wall could be removed, permitting the flame to flow directly into the tubes, so as to raise the water off the tube sheets and thereby decrease, if not eliminate the trouble.

Boston, Mass. L. A. H. MERRIHEW.

Theory and Practice

I read with interest the "Foreword" in the March 13 issue. It is timely and to the point.

That the practical men take unholy delight in the misadventures of theoretical men cannot be denied. But is it any wonder, when there are so many of the latter that are bluffing their way through, drawing large salaries, holding positions above good practical men that are not wholly lacking in some theory themselves?

The sort of man spoken of in the last paragraph of the article is the kind that is really worth something. In fact, it is difficult to estimate how valuable such men are. But there are far too few of them, and it is safe to say that most practical men are glad to work under such men as these, because they are sure to learn much thereby. I wish to cite two examples of the kind of a man that brings so much disrepute upon theoretical men in general from those on the practical side.

Some time ago a large manufacturing firm employed a man that had never had the opportunity or inclination to gain any practical knowledge whatever, so he was totally ignorant of what is actually required to make his ideas work out successfully in practice. On one occasion he wanted a pump for temporary use, and there happened to be a large duplex pump in the plant that had been dismantled and set aside. He reasoned that he might make use of it, but it being far larger than necessary, he decided to use one-half of it only; that is, one steam cylinder and its water cylinder, it being so constructed that the two sides could be detached one from the other by cross-connections. When asked how he intended to operate it, he replied "just like any steam pump." Needless to say, it never pumped much water.

After his departure from the firm there appeared another who seemed to be of a different type, and he had the title "Works Engineer" attached to his name. But he proved to be similar in many respects to his predecessor. He issued instructions to the boss of the yard gang to clean up the plant and gather up material that could be used and sort it out. He enumerated a number of things to gather up, among them being all the "loose keyways."

On another occasion a boilermaker was making some minor repairs on a locomotive boiler, and he informed the man of theory "that the crown sheet had a crack in it." He told the repair man to get it out so it could be repaired that day, ready for use the next morning.

Now can you always blame the practical man?

Hamilton, Ohio. JOSEPH STEWART.

Troubles Experienced in Pumping Hot Brine

With reference to the letter of M. C. Cockshatt in the March 20 issue, I wish to make some suggestions with reference to pumping brine and the troubles encountered with packing and water seal on glands.

It is possible that the casing or shaft is worn so that there is too much head pressure on the stuffing box and packing. If there is no check valve on the discharge line and the evaporator pressure goes a little higher than the pump discharge pressure, or primes, it will back up and carry over salt into the pump.

There is available a pure rawhide packing and also a soft lead rubber-inserted metallic packing in which, when heated, the rubber becomes vulcanized and therefore makes a solid form on the shaft. We have used it on some jobs where high-pressure packing lasted only from 12 to 20 hours, and it has stayed in three months on the same service. The rawhide also is soft and becomes easily attacked when in contact with heat.

It is possible that the seal becomes air or vapor bound. If cold water could be supplied to the gland, it would help considerably in relieving this trouble. If the sealing pipe is connected to the pump casing at a point where there is not much pressure, better results might be obtained, by connecting it to the discharge connection where the highest pressure is maintained.

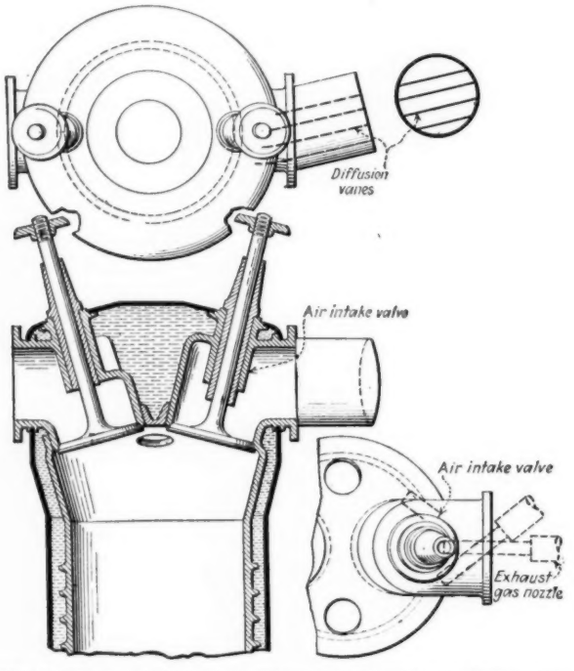
B. W. HAY.

Bedford, Ind.

Directed Turbulence in Oil Engines

In *Power*, Jan. 30, under the title "European Oil Engines," Edvin Lundgren emphasized that the two conditions essential to dispensing with air injection in oil engines were: (1) Turbulence of the fresh charge of air at the time the fuel is sprayed into the combustion chamber; (2) the careful directing of the motion of air into the path most likely to distribute the oil spray.

I had an experience with a solid-injection engine that may be of interest. Fig. 1 represents in outline the top view of a 5x7-in. four-stroke-cycle engine with which solid injection was tried. The high speeds attempted, of between 1,700 and 1,800 r.p.m., made early injection necessary in order to give time enough for the fuel to vaporize and mix without giving late



ARRANGEMENT OF DIRECTOR DIFFUSION VANES ON A LIBERTY ENGINE

burning. The injection system, however, permitted advancing the time of starting injection only by several degrees of crank travel at each adjustment. This meant that while one setting might cause late burning at the desired speed, the next setting would give preignition unless the jacket-water temperature was dropped below the chosen value.

To hasten mixing, I had a "director" made for the entering air, somewhat as shown in Fig. 1. Since the inlet valve stem and its guide were on a slant to the face of the inlet flange, the device could not be turned over and used to deflect the air to the right or to the left. It happened that, when made, it had to be so set in the inlet that any possible whirl given to the entering air started the air flowing in the direction away from rather than toward the fuel nozzle. Owing to vibration no reliable indicator cards could be taken for detecting any differences made upon the combustion lines by the use of this director. Speed and load showed no gain from using it, and since the air had to take a downward turn through the port opening after being deflected horizontally by the diffusion vanes, it was considered that the effect of the director was lost.

Some weeks later it was desirable to obtain more capacity from the engine without changing the speed. This meant that more fuel had to be supplied which in turn necessitated advancing the injection, because at that time a particular nozzle and injection pressure were under trial. Rough running resulted, and an indicator card doubtless would have showed too much peak. As a preliminary trial of what effect a change in the rate of combustion might produce, some cooled exhaust gas was fed to the engine.

To have added an inlet pipe to direct the dose of CO_2 would probably have blanketed the influence of the CO_2, because at 1,700 r.p.m. "ramming" effects from the inertia of the column of rapidly flowing air can be appreciable, and although the volumetric compression ratio remains constant, the increased compression pressure arising from a slight increase in the suction pressure, can be sufficient to start ignition. And earlier ignition was not wanted.

Hence a smooth nipple was attached with one end inside the engine inlet, and pointing about square with the inlet flange, as shown to the right in Fig. 1. The exhaust gases were fed continuously from the gas-cooling tank by a small Roots blower and through a control valve and rubber hose to the nipple.

The engine was given a light dose of this cooled exhaust gas, but nothing happened. The dose was increased by opening the control valve wider, and accidentally the rubber hose got a kick or two that moved the nipple so that it pointed not perpendicular to the inlet face but toward the fuel nozzle. The speed went up until the pounding became serious.

The first inference was that the blower inlet leaked and was taking in more air than exhaust gas, and that with the control-valve opening increased, the flow of highly diluted exhaust gas from the blower had super-charged the engine. It was also assumed that the exhaust gas was not as cool as the room temperature and acted slightly as a preheater for the charge of air. Both of these theories were exploded when, on pointing the nipple toward that side of the inlet away from the fuel nozzle, the engine would not repeat its performance. Dipping the nipple toward the port opening as well as in the direction of the nozzle, intensified the engine pounding and high speed.

ROBERTSON MATTHEWS.

Hampton, Va.

Combustion Control for Steam Boilers

Referring to the article on "Combustion Control for Steam Boilers," by Charles H. Smoot, in the March 6 issue, I think that one of the principal factors of complete combustion control has been omitted from the list which is given in the second paragraph; namely, control of the draft over the fire. The draft over the fire, when kept automatically at a constant low figure, will sometimes effect greater economies in combustion than can be obtained by control of fuel feed and air supply or by correlation between these two. I think the author should have shown this as item "D" in his list, at least. No discussion of combustion control in steam boilers is complete without discussion of control of the draft over the fire.

Mr. Smoot advocates permitting greater changes in steam pressure with large boilers than with small ones before making a change in air supply or fuel feed. He also says that boiler-combustion control is by no means steam-pressure regulation.

In many plants constant steam pressure is of great importance, and considerable thought and effort are expended in obtaining it. The larger the plant the more important the matter of steam pressure. With very large turbines connected to the boilers a few pounds difference in steam pressure may make a great difference in output and regulation. I do not think most operators would be willing to permit steam pressure to fluctuate in order to obtain more economical boiler operation.

The proper way to obtain economy is to govern the draft over the fire and keep it constant at a low amount automatically. If the air supply is controlled as to volume from the steam pressure and the damper in the breeching is controlled from the draft over the fire, constant steam pressure can be obtained and the only loss of economy will be due to combustible in the ash. This can be prevented with a small amount of manual attention. In actual practice there is usually very little difficulty with incomplete combustion forming CO.

In any discussion of automatic fuel feed it seems important to state that no system of fuel feed yet invented can operate more than four to six hours on fluctuating load without manual attention. This being the case, the attention of the engineer should be focused on automatic control of air supply to give constant steam pressure and automatic control of draft over the fire to give highest economy. Fuel feed should be correlated with air supply as the author so fully points out, but with that point conceded, almost any system of governing it will suffice. Manual control, which is necessary in any case as a supplement to the automatic control, will take care of such defects as appear. EDWARD M. ELIOT.

Detroit, Mich.

[The effect that a given variation in steam pressure will have on the output and regulation of a turbine will be controlled to a large extent by the rated pressure. At low pressures, say 100 lb., ten pounds variation will be of considerable importance, whereas with steam at 300 lb. the effect would be small. No doubt many operating engineers would like to know what importance is placed on constant steam pressure in different plants. *Power* invites an exchange of opinions from its readers on this subject.—Editor.]

Can Return Traps Be Used for Boiler Feeding in Connection with Venturi Meters?

Referring to Mr. Akers' inquiry in the March 27 issue, Can return traps be used for boiler feeding in connection with venturi meters? there is no difficulty in doing this provided proper arrangements are made. As the working principle of the return trap is to equalize the pressure above the water in the trap with the steam space of the boiler and then allow the water to flow into the boiler by its hydrostatic pressure due to the elevation of the trap above the boiler, sufficient elevation must be secured not only to lift the checks and to compensate for loss of pressure in the steam connection to the trap, but also to overcome the resistance of the water piping, fittings and valves as well as the numerous valves and checks of the trap, at the highest rate of flow necessary to handle the water. If a Venturi meter is installed, sufficient allowance must be made for its resistance, which varies according to the working head of the meter, amounting usually to about 15 per cent of the differential head. Venturi meters generally use from 15 to 22 inches of mercury maximum working head, requiring from three to four feet additional elevation to overcome the resistance at the maximum rate of flow.

The flow from return traps is intermittent but not rapid enough to cause pulsating flow errors; but the regulating valve in the mercury chamber should be slacked back so as to allow the meter to respond readily to the changes in the rate of flow.

My experience has not been particularly satisfactory with return traps as boiler feeders, as they do not have the steady positive action of a duplex pump and are subject to sticking and going out of service on account of comparatively minor troubles in pivot bearings, swivel joints, etc.; and they must usually be located in inaccessible places to obtain the necessary elevation above the boilers required for satisfactory service, so that it is hard to give them the amount of inspection and supervision the boiler-feeding apparatus should have.

However, there has been recently considerable improvement made in the design of return traps, and the workmanship on them is now comparable with a good steam pump, and these will doubtless show corresponding results in service. H. D. FISHER.

Colver, Pa.

Increasing the Output of a Semi-Diesel Engine

In the issue of Feb. 24, S. M. Howe describes some experiments that he made on a semi-Diesel engine to increase the power output by finding the best length of exhaust pipe. He also remarks that the power dropped when there was no exhaust pipe fitted. These experiments agree with some I have carried out with a four-cylinder automobile engine on the test bed. I found that the power increased at certain speeds with the exhaust manifold in place, whereas with the manifold removed and exhausting into the test room, the power fell quite considerably.

Regarding the increased power with variations in the length of the exhaust pipe, this is caused by the flow of gases along the exhaust pipe, which causes a partial vacuum in the pipe. This has a scavenging action on the next charge of exhaust gas that comes from the cylinder. The length of the exhaust pipe is therefore of importance if it is desired to obtain the maximum power from the engine, as it is possible to find a certain length of pipe that will give pressure waves in resonance with the engine speed. The power output of a semi-Diesel or any other type of internal-combustion engine can be increased by experimenting with various lengths and diameters of exhaust pipe.

Glasgow, Scotland. DOUGLAS P. MUIRHEAD.

It frequently occurs in connecting steam pipes to steam chests of turbines, that no allowance has been made for the movement due to the expansions of the steam line, the result being that strains due to this expansion are transferred to the cylinder casing and produce a condition dangerous to operation. Before the steam pipe is bolted to the steam chest, its position should be noted. It should then be heated to its operating temperature and the amount of movement measured. Midway between these two positions should be the point for connecting the pipe to the turbine.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Melting Points of Cast Iron and Steel

What are the temperatures of melting points of cast iron and of mild steel, and what is their appearance at those temperatures? A. E. M.

The melting points are about as follows, varying with the analysis and density of the specimens: White cast iron, 2,100 deg. F.; gray cast iron 2,200 to 2,700 deg. F.; mild steel 2,700 deg. F. The appearance at temperatures above and below the range of melting points quoted varies approximately as follows: Deep orange color, 2,010 deg. F.; white, 2,370 deg. F.; bright white, 2,550 deg. F.; dazzling white, 2,730 deg. F.

Advantage of Operating Boiler at Lower Pressure

We have two water-tube boilers operated at 120 lb. gage pressure and burn 20 tons of coal in 24 hours. How much coal should be required if the boilers are operated at the pressure of 95 lb. gage? E. F. N.

If the steam output is used for heating purposes, the same amount of coal would be required for service of the same amount of heat, except that with the lower-pressure steam there may be less waste of heat from uncovered pipes, discharge of traps or carelessness in uses of live steam, such as in allowing steam to blow to waste while warming up pumps, engines, steam kettles, heating coils and so forth.

If the steam generated by the boilers is used in a cutoff engine, there might be a difference in coal economy, depending on the length of cutoff required by the same load. If the engine is too large for the load, requiring very short cutoff, and especially with expansion carried below the pressure of the exhaust, there would be greater economy from a lower initial pressure, but in most cases there would be practically no difference between throttling from 120 to 95 lb. pressure or receiving the steam from the boiler at the latter pressure.

General Assemblage of Engine

What would be the method of assembling the piston, piston rod, crosshead, connecting rod and crankshaft of an engine? J. A. F.

First remove the back cylinder head and see that the shaft bearings are square with the cylinder center line and that the guides are parallel and in line with the cylinder center line, and place the crosshead in the guides in proper line and level for receiving piston rod.

Place the shaft in its bearings and see that the shaft is square with the cylinder center line when the boxes are set and then slacken the caps sufficiently for the shaft to be turned over for checking other adjustments.

Secure the piston permanently to its rod and place the piston in the cylinder with the rod extending through the stuffing box and gland, and temporarily set the rod in the crosshead. Next, replace the cylinder head and set the gland firmly in the stuffing box, without packing, by tightening the flange against parallel wood blocks placed between the flange and the end of the stuffing box. Now move the piston as far as it will go, first in one end and then the other end of the cylinder, and each time make a mark on the piston rod against the end of the gland, and make a mark halfway between these marks for determining the position of the rod for midstroke of the piston when there is the same piston-travel clearance at each end of the cylinder.

Then assemble the connecting rod and turn the crank first on one dead center and then on the other, each time making a new mark on the piston rod at the end of the stuffing box gland, and find a point halfway between these last made marks. If the new halfway mark does not come at the same place on the rod as the previously made mark for midstroke, change the shimming of the connecting-rod brasses or adjust the distance of the piston rod in the crosshead (if that is permissible without leaving less than about one and one-half diameters of a screwed rod end in the crosshead) or by making both adjustments, as may be necessary to make the middle mark between marks at dead center agree with the midstroke mark on the rod. A few trials should make the adjustments correct, and when the middle mark agrees with the midstroke mark, the piston will have the same clearance from one end of the cylinder as the other. After the adjustments are corrected, tighten the jamb nut or other fastening of the piston rod to the crosshead.

Load on Air Compressor

Q. We have a 6 x 6-in. single-acting air compressor which is to be belt-driven by a 5-hp. motor. The discharge pressure is to be 90 lb. gage. How can the load on the motor be regulated to prevent overload? C. G. R.

A. The work done by the air-compressor piston upon the air is the reverse of the process in a steam engine and the horsepower required to operate the compressor is

$$Hp. = \frac{PLAN}{33{,}000}$$

where P is the mean effective pressure in the cylinder, L the length of the stroke in feet, A the area of the piston in square inches and N the number of working strokes per minute.

There are two ways to control the load, as shown by this formula: P, or the mean effective pressure, can be altered by changing the delivery pressure, or the speed

may be altered. Since the discharge is to be 90 lb. gage, obviously the adjustment must be by speed only.

The first step in determining the correct speed is to find the mean effective pressure. The formula for mean effective pressure is

$$m.e.p. = 3.44\, P_s \left[\left(\frac{P_d}{P_s}\right)^{0.29} - 1\right]\left[1 - \%Cl\left[\left(\frac{P_d}{P_s}\right)^{0.71} - 1\right]\right]$$

Here P_d = Absolute discharge pressure, $(90 + 15)$;
P_s = Suction pressure, or 15 lb. absolute;
$\%Cl$ = Per cent clearance, assumed 3 per cent.

Substituting these values,

$$m.e.p. = 3.44 \times 15\left[\left(\frac{105}{15}\right)^{0.29} - 1\right]\left[1 - 0.03\left[\left(\frac{105}{15}\right)^{0.71} - 1\right]\right]$$

or $m.e.p. = 35.65$ *lb.*

Using this value in the formula for horsepower together with the value of the other symbol already given, the formula becomes

$$5 = \frac{35.65 \times 1\frac{6}{2} \times 6 \times 6 \times 0.7854 \times N}{33{,}000}$$

which makes the r.p.m. N equal to 327. So far belt slippage and friction losses have been ignored. If these total 10 per cent, the compressor speed will then be 294 r.p.m.

Corliss-Engine Economy Under Different Conditions

How does the economy of simple and of compound Corliss engines vary operating non-condensing or condensing when supplied with steam 100 to 200 lb. gage pressure with different degrees of superheating?

W. L. T.

There will be a difference in the economy of different engines according to their size, design, speed, load and leakage of valves and pistons. However, when operated at full load and usual speeds, modern Corliss engines of good design and in good working condition may be

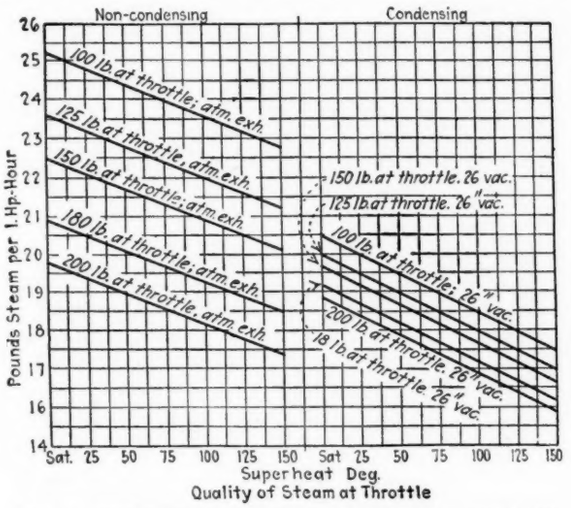

Non-condensing
Condensing
100 lb. at throttle; atm. exh.
125 lb. at throttle, atm. exh.
150 lb. at throttle; atm. exh.
180 lb. at throttle; atm. exh.
200 lb. at throttle, atm. exh.
150 lb. at throttle. 26 vac.
125 lb. at throttle. 26 "vac.
100 lb. at throttle; 26 " vac.
200 lb. at throttle. 26 "vac.
180 lb. at throttle. 26 "vac.
Pounds Steam per I. Hp-Hour
Sat. 25 50 75 100 125 150 Sat. 25 50 75 100 125 150
Superheat Deg.
Quality of Steam at Throttle

FIG. 1—EXPECTED ECONOMY OF SIMPLE CORLISS ENGINES OPERATING NON-CONDENSING AND CONDENSING

expected to have the economies shown by the charts Figs. 1 and 2. For instance, as indicated by the chart Fig. 1, for a simple engine operating non-condensing, steam 100 lb. gage pressure at throttle, 25 deg. F. superheating and atmospheric exhaust, the expected economy would be 24¾ lb. of steam per indicated horsepower-hour; and operating condensing, with steam 100 lb. gage pressure at throttle, 25 deg. F. superheat and 26 in. vacuum, the expected economy would be 20 lb. of steam per horsepower-hour.

As indicated by the chart Fig. 2, for a compound engine when operating non-condensing, steam 100 lb. gage

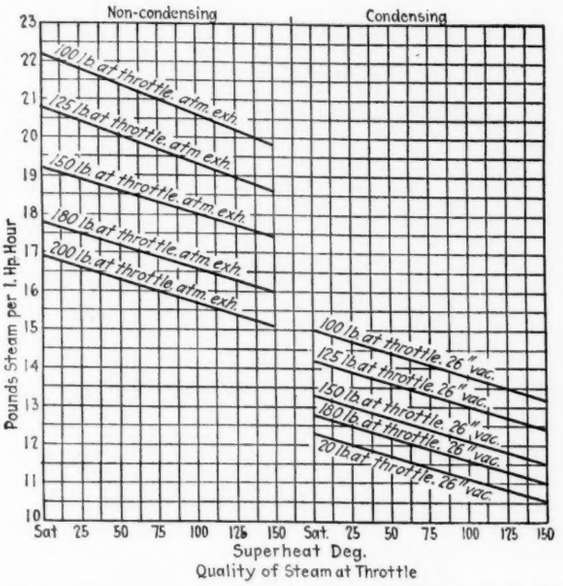

Non-condensing
Condensing
100 lb. at throttle. atm. exh.
125 lb. at throttle. atm. exh.
150 lb. at throttle. atm. exh.
180 lb. at throttle. atm. exh.
200 lb. at throttle. atm. exh.
100 lb. at throttle. 26 " vac.
125 lb. at throttle. 26 " vac.
150 lb. at throttle. 26 " vac.
180 lb. at throttle. 26 " vac.
20 lb. at throttle. 26 " vac.
Pounds Steam per I. Hp Hour
Sat 25 50 75 100 125 150 Sat. 25 50 75 100 125 150
Superheat Deg.
Quality of Steam at Throttle

FIG. 2—EXPECTED ECONOMY OF COMPOUND CORLISS ENGINES OPERATING NON-CONDENSING AND CONDENSING

pressure at the throttle, with 25 deg. F. superheating and atmospheric exhaust, the expected economy would be 21¾ lb. of steam per indicated horsepower-hour; and operating condensing with the same pressure and condition of steam and 26 in. vacuum, the expected economy would be 14¾ lb. per horsepower-hour. The economies charted are to be considered as only approximately relative, rather than actually attainable, by Corliss engines promiscuously selected.

Safety Valve for Compressed-Air Tank

What size of direct spring-loaded safety valve would be required for a compressed-air tank supplied from a compressor having a rated maximum capacity of 180 cu.ft. of free air per minute, compressed to 100 lb. gage pressure?

H. L. C.

The safety valve should have a capacity for discharging a quantity of air at least equal to 25 per cent more than the maximum rating of the air compressor, or $180 \times 1.25 = 225$ cu.ft. per min. The size of 45-deg. level seat safety valve required may be from the formula

$$Q = 28PDl, \text{ or } D = \frac{Q}{28\ Pl}$$

in which

Q = Discharge in cubic feet of free air per minute;
D = Diameter, in inches, of the inside edge of the bearing surface between the disk and seat;
P = Absolute pressure at which the valve opens = $100 + 14.7 = 114.7$ lb. per sq.in. absolute;
l = Lift of valve, taken as $\frac{1}{31}$ of D.

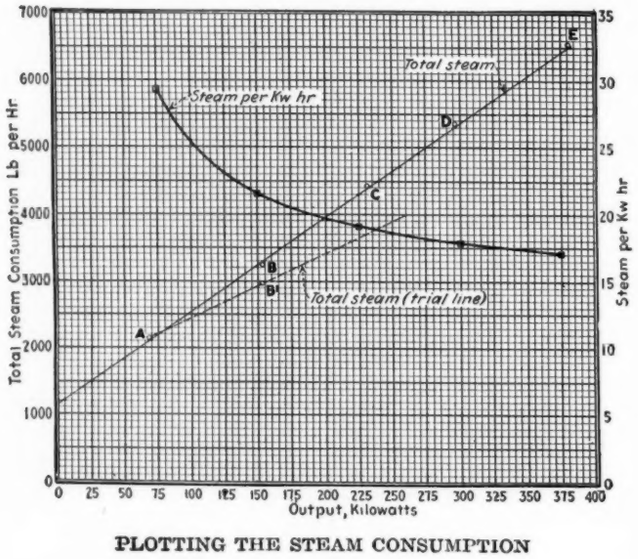
$$D = \frac{225}{28 \times 114.7\ \frac{D}{31}} = 1.47 \textit{ in. dia., or practically } 1\tfrac{1}{2} \textit{ in.}$$

Easy Lessons in Engineering

Plotting a Turbine Test

The general practice of plotting data has had much to do with the rapid advance of engineering. While a "curve" or "graph" contains nothing that is not in the original data, it substitutes a picture for mere figures and thereby shows at a glance many things that might otherwise be overlooked. Again, a smooth curve drawn through a series of experimentally determined points in such a way as to take an average position tends to "iron out" the individual errors that are always present in experimental data.

Where a serious error is made in one or two points, they will fall so far from the curve as to excite suspicion at once. So it is often desirable to plot the data as fast as obtained during the test of a piece of apparatus in order that sources of error may be detected and corrected during the progress of the test.



PLOTTING THE STEAM CONSUMPTION

Suppose, for example, we are testing a condensing turbo-generator unit rated at 300 kw. Arrangements are made to run the turbine at various loads and to measure the kilowatt output and the total hourly steam consumption at each load. This is the essential data. As this article is concerned primarily with plotting rather than with testing, such details as measuring the condensate, getting constant conditions before taking readings, etc., will be passed over without further comment.

Runs are made at five different loads, approximating quarter, half, three-quarters, full load and 25 per cent over load. Let us assume that the figures obtained at quarter load are 68 kw. and 2,140 lb. per hour total steam consumption. These are plotted at once as point *A* (see diagram) on a sheet of cross-section paper lettered in advance with scales suited to the expected size of the readings. The run of half load gives 153 kw. and 2,970 lb. This is plotted as *B'*.

The turbine under test governs by throttling, with all nozzles operating throughout its entire range of load. Now it is well known that the curve obtained by plotting the total steam consumption of a throttle-governed engine or turbine against the load is practically a straight line (called the Willans Line). So draw a dotted straight line through *A* and *B'*. If no errors have been made, the next point *C*, for the three-quarter-load run, should fall on or close to this dotted line. The figures obtained at this load are 231 kw. and 4,420 lb. When these are plotted at *C*, it is found to fall far above the dotted line. This shows at once that a serious error has been made in one of the first three runs. To locate the error, the half-load run is repeated with the results plotted at *B* (153 kw. and 3,250 lb.). As *A*, *B* and *C* now fall practically on one straight line, it is unnecessary to repeat the runs for *A* and *C*.

The full-load run gives 296 kw. and 5,350 lb. When plotted at *D* it falls practically in line with *A*, *B* and *C*, showing that no serious error has been made. The twenty-five per cent overload test is then made, and the results (381 kw. and 6,540 lb.) are plotted at E. A single straight line is then drawn, coming as close as possible to all the points. The fact that none of the points lies far from this line indicates that the work is substantially correct unless the same error has been made in each run. As this is improbable, the straight line may be taken as giving the most reliable values of the total steam consumption for all loads from quarter load to 25 per cent over load. It is now possible to prepare the following table of water rates:

Fraction of Full Load	Kilowatts	Pounds of Steam per Hour	Pounds of Steam per Kilowatt Hour
¼	75	2,190	29.2
½	150	3,240	21.6
¾	225	4,300	19.1
Full	300	5,350	17.8
5/4	375	6,410	17.1

The third column was read directly from the total-steam line, while the fourth was obtained by dividing the third column by the second.

An accurate curve of steam consumption per kilowatt-hour may now be plotted, using the values in the second and fourth columns. This may be drawn on a separate sheet of plotting paper or on the same sheet as shown. When plotting on the same sheet the original horizontal scale for kilowatts is used, but an independent vertical scale is laid out on the right for pounds of steam per kilowatt-hour. In plotting this curve, the line is drawn to pass *through* the five points (rather than close to them). This can be done here because the points came from another smooth curve (the straight line) rather than directly from experimental data.

Welding Developments in the Power Field

Much information of value to those who are concerned with any new developments that touch upon the power field was contained in two papers, dealing respectively with arc and oxyacetylene welding, which were presented at the recent annual meeting of the American Welding Society in New York City. The following abstracts cover those portions of these two papers which are thought to be of more or less general interest to the readers of *Power*. The first paper, "Recent Developments in the Arc-Welding Field," was by W. L. Warner, assistant to the chairman of the Electric-Arc Welding Committee of the American Bureau of Welding, while the second, entitled "The Oxyacetylene Process in 1922," was presented by G. O. Carter, consulting engineer with the Linde Air Products Co. The abstracts follow:

Recent Developments in the Arc Welding Field

Tests were recently made to determine the suitability of various materials for welding purposes. It is generally agreed that a sound weld can be obtained only when the metal fuses evenly and quietly and without excessive sputtering and boiling. This requires a material thoroughly degasified and low in gas-forming elements. Freedom from slag or slag-forming constituents is also essential.

For some time the A.S.M.E. Boiler Code Committee has been preparing a code for unfired pressure vessels, similar to the Boiler Code. This has been published for public hearing twice and as a proposed code once. In a paper read before the International Acetylene Association in Chicago, S. W. Miller, of the Committee on Welding of Pressure Vessels, set forth very clearly some of the facts in regard to the proposed code of the A.S.M.E. It is a second example of how an industry must get together to solve a common problem.

To show that pressure vessels can be welded safely, and to secure data for the Code Committee on this subject by actual tests, a committee was appointed to study the problem. Various manufacturers are furnishing tanks and contributing funds to test them to destruction. These tests should settle the questions at issue, the most important of which is "What test will always detect an unsafe vessel?"

The research activities of the American Bureau of Welding have not been confined to the problems of welding alone, but have gradually broadened as the applications of welding have increased. For example, specifications have been prepared for the welding of oil tanks. A welded tank has many advantages over a riveted tank, one of the most important being the elimination of leakage, which in a riveted tank causes a yearly loss of about 5 per cent of the tank capacity. In a 5,000-bbl. tank this loss represents $1,250, which, if capitalized at 6 per cent, amounts to $20,000. It is also probable that with a little practice the cost of erecting a tank by the electric-welding method will be lower than the cost of a similar tank riveted.

In addition to the work that has been done under the auspices of the American Bureau of Welding, many investigations have been carried on by independent investigators. Some interesting applications of the welding process have been discovered and have been brought to a certain degree of development, although many phases are still in the experimental stage.

Hammer forging has been shown to improve greatly the strength, ductility and fatigue resistance of metals deposited by the electric arc. A few years ago welding currents of the order of 125 amperes were most commonly used. This has gradually been increased until 200 amperes is now not unusual. For large thermal capacities, 300 amperes is sometimes used with coated electrodes. This type of electrode has been greatly improved and appears likely to lead to the arc welding of non-ferrous metals. Indeed, the arc welding of brass with a flux-covered copper electrode is already commercial in England.

In locomotive shops electric welding is extensively used for repairing fireboxes, door sheets and crown sheets. Great stress should be laid on the point that only experienced welders should be allowed to make welds in fireboxes or for any pressure work. The most frequent causes of failure are inefficient and indifferent workmen and the little heed taken to have a perfectly clean and properly prepared job. Suitable equipment and proper electrodes for the work in hand should not be overlooked. The finished result probably is 90 per cent operator and 10 per cent equipment and material, while preparation and operation are about a "fifty-fifty" break.

Arc welding has recently come into use for the manufacture of large low-pressure pipe for dredging and distributing systems. This pipe is made by rolling flat plates ¼ in. thick into cylinders of the desired diameter and 5 ft. or more in length. When the pipe is to be used for steam, it is found advisable to bevel the edges. After welding the longitudinal seam, several cylinders are welded end to end in the trench to form a continuous pipe.

Another application of welded pipe is in the distributing system of central heating plants using low-pressure steam. The pressure in such systems is generally under 25 lb. per sq.in., so that standard pipe of the required size is much heavier than is necessary to withstand the working pressure. An economy is therefore effected by using welded pipe, which is lighter in weight, easier to handle and lower in cost.

It seems to be true that commercially pure iron wire of correct physical properties possesses every essential requirement of a welding-wire material for steel plates, shapes, etc., by either the oxyacetylene or electric-arc process. Whereas, the efficiency of commercial steel plate welded with commercial steel wire may vary, a weld produced with commercially pure iron wire in commercially pure iron plate will consistently approach the characteristics of the plate. The five big factors in the success of any weld are, the welder, design of weld, welding equipment, metal to be welded, and the welding wire.

Methods of determining strength of welds without destroying them have been sought for some time. Recent tests have shown a relation between electrical conductivity and tensile strength. Magnetic tests have also been used. This work, while still in the experimental stage, holds promise of practical application.

The Oxyacetylene Process in 1922

In an industry that has been established as long as has the oxyacetylene welding and cutting industry, there are not likely to be many radical changes. On the other hand, there has been a normal growth which promises to continue in the future.

There is nothing new about the welding of steel pipe, as it has been going on for a dozen years or more, but the welding of pipe in long stretches is a current development and is probably the outstanding feature of last year's work in the oxyacetylene welding field. In this connection attention should be called to a welded pipe line recently laid in Texas. Although 140 miles in length and subjected to 750 lb. oil pressure, this 8-in. line has no coupling joints whatever. In spite of severe service conditions, including a washout which threw the pipe out of its ditch, no leaks developed.

In many other fields there are impressive possibilities for welding pipe lines to carry steam, gas and air, as well as oil. Many such installations are now going in.

An investigation during the past year indicates that some fine steam installations have been made by welding at the Shawsheen Mills of the American Woolen Co., at the Globe Wernicke and American Can Co.'s plants in Cincinnati, the Union Station in Indianapolis, Warren Iron & Steel Co., Warren, Ohio, and the J. & P. Coats Co., Pawtucket, R. I. These are just a few of the installations that have been investigated and checked up. In all there are probably at least 1,000 plants in the United States where welded joints have found some application. An interesting example is the plant of the Whitin Machine Co., Whitinville, Mass., where the power plant is being reconstructed, and an oxyacetylene welded installation permits the hooking up of new boilers as fast as they can be installed in place of those which are being removed, one or two at a time. The engineer of the Whitin plant was facing a serious problem to keep his

plant operating during the reconstruction period, and has been wonderfully impressed by the way the welding process has permitted the work to go on without interfering with the normal operation of the plant.

In the investigations of the welding of pipe it has been found that in every place where successful welding has been done a great deal of attention has been paid to the selection of welders and the testing of the finished work. The test of pipe installations can be made very easily by filling them with water and hammering the joints. This test, incidentally, is similar to that proposed for welded unfired pressure vessels.

A study of maintenance and repair welding has brought out very strongly that there has been a lack of knowledge about the correct methods of handling cast-iron welding. When plants have been instructed to preheat work properly, and follow the welding operation with annealing, the results have been entirely satisfactory.

Advance in Manufacture of Steel for Castings

In the March issue of the *Valve World*, L. W. Spring, chief metallurgist of the Crane Company, presented an interesting article on this subject, in which he pointed out the growing importance of steel castings in construction work and in hydraulic, steam and oil engineering. Automobile and truck manufacturers, as well as the building and railway equipment industries, are making extensive use of steel castings. In the power plant, even for saturated steam and comparatively low temperatures, steel castings are used, and for the higher steam pressures accompanied by the temperatures attendant upon the use of superheated steam their use is almost imperative. Another conspicuous instance is the gasoline industry, where the huge demand for motor fuels has resulted in the high-temperature "cracking" processes involving temperatures of from 700 to 1,000 deg. F. and wide ranges of pressure.

For all these needs material of the highest grade is more necessary than ever before and in the end it is the least expensive. Cast and forged steel flanges, fittings and valves are the materials to be relied upon for such demands. With its great strength and high elastic or "service" limit, cast steel carries good ductility, which means safety under severe shock or uneven bolting and warpage strains. Therefore, according to the author, it is the dependable material where an ample factor of safety under strenuous service is desired.

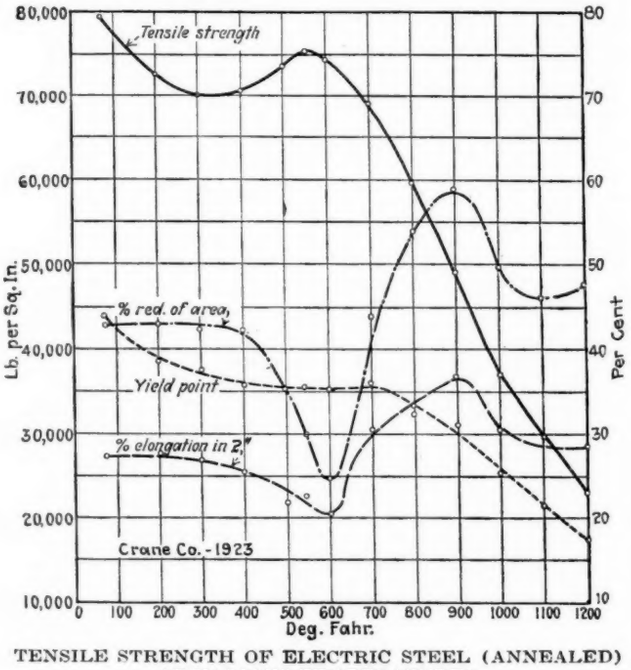
During the last three years cast steel, manufactured by the "basic" process in a Heroult electric furnace, has shown a great advance in quality. While the old steel was thoroughly good and dependable, it cannot compare with basic electric steel as now made. By the new electric-furnace process the deleterious substances, sulphur and phosphorus, are practically abolished, and besides requiring no air for burning fuel used for melting (as is necessary in all other processes except the crucible and electric furnace, where no fuel comes in contact with the metal), any oxygen that may get into the steel from the materials themselves or through access of air, is removed by the final "deoxidizing" and "desulphurizing" slag cover, which is an essential part of the basic electric steel process.

Not only chemically, with its uniformity of analysis, low phosphorus, low sulphur and oxygen, is the improvement shown, but both the physical properties and serviceability testify to the high quality of basic electric cast steel. The metal is known for its high elastic limit (yield point) which runs proportionally higher in comparison with the tensile strength than the elastic limits of steels manufactured otherwise. Along with this high tensile strength and elastic limit go high "elongation" (stretch) and reduction of area of the test piece when pulled to its breaking point.

It must be recognized, however, that the fact that a steel is "melted" in an electric furnace is not necessarily a criterion that it is quality material. By this Mr. Spring does not imply that good steel cannot be made by other than the basic process, but the electric furnace is used too often simply as a melting pot in which to melt down in the shortest possible time, steel scrap to pour into molds and bear the magic name "electric steel castings." Rightfully, the electric furnace should be used for what it is—an almost perfect device for making the highest grade of cast steel at a reasonable cost and in a reasonable time through application of modern metallurgical knowledge.

There are faster and cheaper processes of making electric steel than by the basic electric process using the Heroult furnace, but the simple fact that practically all the high-grade alloy steels, including nickel, nickel chrome, chrome, vanadium, molybdenum, and other steels that go into the modern automobile, and a great proportion of the high-speed tool steels are made by this same basic electric process, is positive proof of its standing.

Within the last few months the Crane Company's testing laboratories have made complete tests of basic electric steels at high temperatures, the temperature range in the tests having been carried up to 1,200 deg. F. As shown in the accompanying curves, the present cast steel is as strong at 1,200 deg. F. as the old steel was at 900 deg. F. and the yield points also carry the same relation. The new steel at 900 deg. F., which is incipient red heat (in a darkened room), has a tensile strength of approximately 50,000 lb. per sq.in. with a yield point of 30,000 lb. At 700 deg. F., the usual top of the superheated steam-temperature range, it has a tensile strength of 69,000 lb. and a yield point of 36,000 lb. per sq.in. These figures and the curves tell their own story.



TENSILE STRENGTH OF ELECTRIC STEEL (ANNEALED) AT VARIOUS TEMPERATURES

From a report upon the Generation of Electricity in Great Britain for the year ending March 31, 1922, just issued by the Electricity Commission, it appears that the average fuel consumption per unit generated, of stations having an output between 100 and 200 million kilowatt-hours, is 2.41 lb. of coal, and for the two- to five-million unit station, 5.03 lb. Eighty per cent of the stations, however, have an installed capacity of less than 10,000 kw. There is one station in the London and Home Counties District having an output of between 10,000,000 and 25,000,000 kw.-hr., which is generating at 2.04 lb. of coal per unit with a thermal efficiency of 15.2 per cent, the next best result in this class being 2.19 lb. of coal with a thermal efficiency of 14.95 for a station in northeast Midland district. The best thermal efficiency reported was 17 per cent.

An analysis of coal giving the percentages of moisture, volatile, fixed carbon and ash is called a *proximate* (not *approximate*) analysis, as distinguished from an *ultimate* analysis that gives the percentages of the various chemical elements, carbon, oxygen, hydrogen, etc.

News in the Field of Power

Centennial of the Delaware & Hudson Co. Celebrated

The one-hundredth anniversary of the founding of the Delaware & Hudson Co. was celebrated on Monday evening, April 23, by a dinner at the Hotel Astor, New York, the participants numbering between five and six hundred. E. H. Outerbridge presided.

Leonor F. Loree the eighth and present president of the company, served as toastmaster and talked most interestingly of the inception and development of the company. It was created to market coal, and its first shipment of coal arrived at New York on the sloop "Tripler" on Dec. 10, 1824, but its first dividend was paid in 1826 from the profits of a banking business conducted at 13 Wall St. It built a railroad 16 miles long, crossing the Moosic Mountains between Honesdale and Carbondale, over which the first load of coal passed in 1829, the year that Stevenson demonstrated the practicability of the locomotive at Rainhill. This railroad was operated by horses on the moderate gradients and by winding drums operated by stationary steam engines or water power on the inclines.

During the period of construction Horatio Allen, one of the company's engineers, had been sent to England with authority to purchase four locomotives. One of these, the "Stourbridge Lion," the first locomotive to run in America, arrived in New York on May 13, 1829, but was so heavy that it crushed the strap-iron rail into the soft hemlock stringers, so that it was impossible to put it into regular service.

From these small beginnings the great railway system of the country has developed. Mr. Loree said: "The power and majesty of the nation of today are founded upon railroad efficiency, an efficiency developed out of the potentialities of economic incentives, individual initiative and freedom of contract. Without these factors there would have been no American railroad system, as it is known to us, and without such a system the American people and nation, as they are known to the world, could never have come into existence." He concluded with a plea for moderation in governmental regulation.

James S. Alexander, president of the National Bank of Commerce, spoke upon Banking and Transportation," and H. W. Dickinson, Assistant to the Director of the Science Museum, South Kensington, London, on "The Use of Steam Power." His address will be abstracted in an early issue.

President Appoints Burgess Head of Standards Bureau

At the suggestion of Commerce Secretary Hoover, the President has appointed George K. Burgess to be Director of the Bureau of Standards. Since 1913 he has been chief of the Bureau's Division of Metallurgy. His service with the Bureau, however, dates from 1903.

The appointment of Mr. Burgess follows several months of futile search on the part of Secretary Hoover for an

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GEORGE K. BURGESS

outstanding physicist who had not been connected with the government service, with sufficient means to allow him to make the sacrifice of income that would be entailed in the acceptance of a Bureau directorship. Mr. Hoover's investigations revealed that physicists in the front rank of their profession are being paid salaries ranging from $18,000 to $20,000. He combed the country for a man possessing the requisite qualifications for this important government post, but found no one of those who was acceptable to him who could be induced to take the place at the salary available.

While it was Mr. Hoover's desire to bring into the Bureau a man from the outside who could be expected to have ideas and plans, prompted by his outside contacts, he recognized that the next best thing would be to promote some member of the Bureau's staff, who would have the advantage of an intimate knowledge of its work and problems. While his choice happened to fall on the ranking member of the Bureau's staff, Mr. Burgess' colleagues are unanimous in agreeing that he is best qualified to undertake the directorship.

Mr. Burgess was born in Newton, Mass., Jan. 4, 1874, and received his B. S. from Massachusetts Institute of Technology in 1896. He held a fellowship at that Institution from 1898 to 1900. His Sc. D. was obtained in Paris in 1901. He served short terms as instructor at the University of Michigan and at the University of California. He served the Bureau of Standards from 1903 to 1905 as an associate physicist. From 1905 to 1913 he was a physicist and in the latter year was raised to the rank of chief of division.

Mr. Burgess has been active in the work of the National Research Council. During the war, in addition to his regular duties, he was an adviser to the requirements division of the War Industries Board and to the Ordnance Department of the Army. In 1917 and 1918 he was chairman of the light alloys committee of the National Advisory Committee for Aëronautics. During the same period he was a member of the National Aircraft Standards Board. He was the recipient of a silver medal at the Pan American Exposition held in 1915.

New Power Plant to Be Built on Fall River

The signing of the Massachusetts Senate Bill No. 322 on April 18 by Governor Cox marks an important step in the formation of superpower zones for furnishing power economically to electric light companies in New England. This bill allows electric companies in Massachusetts to unite in financing and building superpower stations that can be located on tidewater and realize the best possible economies both in fuel cost and in general operating costs, so as to furnish power at the lowest possible rates to the groups of companies that take part in the building of the combined stations.

The first of these combined plants will be built by the Fall River Electric Light Co., together with the Edison Electric Illuminating Co., of Brockton, and Blackstone Valley Gas and Electric Co., which supplies light and power to Pawtucket, Woonsocket, Central Falls, and other sections of the Blackstone Valley in Rhode Island. The big plant will be located on Mt. Hope Bay at Fall River and power will be supplied in large amounts over 15 miles of transmission line to Pawtucket and 29 miles of line to Brockton. The plant design provides for an ultimate capacity of 200,000 kw., and the building of the power station and installation of the first unit of 30,000 kw. capacity will require an initial expenditure of about $5,500,000.

Stone & Webster, Inc., of Boston, will

design and construct the plant and transmission lines. The general building activity among electric light and power companies and other public utilities is indicated by the fact that Stone & Webster now have under design and construction steam-power station work and transmission-line work amounting to $35,000,000. This firm is also doing hydro-electric development work and other building amounting to as much more.

Engineers Welcome Secretary of Newcomen Society

L. F. Loree, president of the Delaware & Hudson R.R., gathered a number of engineers and editors of engineering periodicals at luncheon at the Bankers' Club on April 20 to meet H. W. Dickinson, Honorary Secretary of the Newcomen Society of England and curator of the South Kensington Museum. Mr. Dickinson is in America as one of the principal speakers at the dinner given at the Hotel Astor April 23, in celebration of the One Hundredth Anniversary of the founding of the Delaware & Hudson Co. John R. Dunlap, president of The Engineering Magazine Company, was toastmaster and introduced Henry R. Towne, chairman of the Board of Directors of the Yale & Towne Manufacturing Co., and past president of the American Society of Mechanical Engineers; William L. Saunders, chairman of the Board of Directors of the Ingersoll-Rand Co. and past president of the American Institute of Mining & Metallurgical Engineers; F. R. Low, editor of *Power*, and David Beecroft, directing editor of the Class Journal Co., publishers of automotive papers. Mr. Loree introduced Mr. Dickinson, who talked interestingly and impressively of the importance of preserving the history and tradition of engineering, and the purposes and efforts of the Newcomen Society in this direction.

To Build Propeller-Type Turbines of 30,000 Hp.

A contract for the hydraulic machinery and equipment for the new St. Maurice Power project of the Shawinigan Water & Power Co., of Montreal, Canada, has just been awarded to the Dominion Engineering Works, Limited, of Montreal, Canadian licenses of the William Cramp & Sons, Ship & Engine Building Co. There are to be four 30,000 hp. propeller-type turbines, the largest of this type in the world, exceeding in unit capacity those recently completed for the Manitoba Power Co. at Winnipeg. The new station, when completed will give the Shawinigan Co., from its three plants on the St. Maurice River, a total of one-half million horsepower. Construction work on the dam and foundations is already under way, under the immediate supervision of Vice-President Julian Smith of the Shawinigan Water & Power Co. Mr. Smith has promised that the entire plant will be ready in June, 1924, and if this schedule is carried out it will make a record for speedy construction for plants of this size.

The turbines are to operate under a normal head of 60 ft. and to run at a speed of 130 r.p.m. Their performance will be watched with much interest by engineers, as they are to embody a number of improvements which are expected to make the St. Maurice installation a distinct advance in the turbine art. The electrical equipment will be furnished by the Westinghouse Electrical & Manufacturing Co.

New Jersey Department of Labor Entertains

The annual banquet, entertainment and dance of the Department of Labor, State of New Jersey, was held at the Riviera Hotel, Newark, N. J., on Thursday evening, April 19. Covers were laid for fully three hundred guests. A hearty welcome was tendered to Lewis T. Bryant, Commissioner of Labor, who because of his commendable work in the past, was recently reappointed. At the dais table were many prominent members of the department, who made interesting and instructive addresses. An unusually pleasing entertainment program was rendered and was cordially received. In the afternoon the members of the department enjoyed an automobile ride to various points of interest.

Navy Department Opens Bids for Coal

Prices of $4 or better, at the mine, will be paid by the Navy Department for the coal tendered on the bids opened last week. Eleven bids were received, which is quite in contrast with the results last year, when only one response came to the call for bids. At the advice of F. R. Wadleigh, a call for bids was made at this time which was thought to be the most opportune and convenient.

For the coal to be delivered at Hampton Roads between July 1 and June 30, 200,000 tons was awarded to the Pocahontas Fuel Co., Inc., at a price of $6.72. The Fayette Smokeless Fuel Co., of Mount Hope, W. Va., was awarded a contract for 108,000 tons at the same price. A contract for 100,000 tons was awarded the Crozer-Pocahontas Co., of Philadelphia, at $6.50. Castner, Curran & Bullitt Co., Inc., of New York, was given a contract at $6.68 for 100,000 tons for Sewalls Point delivery. It was the desire of the Navy to award a contract for 200,000 tons for Sewalls Point delivery, but the contract for half that amount meets the situation, for the present at least.

At the end of 1922 most of the larger electric power-producing companies were in a position to declare larger dividends than at the end of 1921, says a report to the Department of Commerce.

New Publications

Thermodynamics and the Free Energy of Chemical Substances. By Gilbert N. Lewis, Professor of Chemistry, and Merle Randall, Associate Professor of Chemistry, University of California. Published by McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City. Cloth; 6x9 in.; 653 pages. Price, $5.

Modern chemistry is coming to depend more and more on thermodynamics, which permits definite predictions in many problems whose solution was formerly possible only by repeated trials and guesses. This book is a treatise designed to meet the needs of chemists who have already some acquaintance with thermodynamics, but feel the need for a more thorough grounding in the fundamental principles and their application to the research problems of pure or applied chemistry. While not an elementary book in any sense, nor free from the necessary minimum of mathematics, this volume is characterized by the skillful use of words to explain the inner meaning of the mathematical expressions. The first part of the book is devoted to a presentation of the elements of thermodynamic theory and, while written primarily for chemists, should help the engineering student of thermodynamics to obtain a broader conception of the subject. For the chemist the latter portion of the book, dealing with solutions, chemical equilibrium, electrolysis, vapor pressures, disassociation, etc., contains much of fundamental importance.

Robert Fulton and the Submarine. By William Barclay Parsons. Published by The Columbia University Press. Cloth; 6½x9½ in.; 154 pages; 16 illustrations. Price, $4.

While Robert Fulton is entitled to a prominent place in history, the niche he occupies in the Hall of Fame by reason of the invention of the steamboat is undeserved. The real inventor of the use of steam for marine propulsion operated a small boat on the Delaware long before Fulton launched the "Clermont." What little credit due Fulton is that of combining a fairly good engine with an improved paddle-wheel. Fulton's real contribution to the world's development was in the construction of a workable submarine. While the idea of a vessel that could be submerged was advanced centuries ago, Fulton was the first who transformed these hazy theories into a working model. The reader of this volume will on first thought probably find it a matter of wonderment that Fulton's submarine boat plans were not accepted by the French government when presented in 1798. Even the arrival of Napoleon on the scene as dictator failed to change its attitude. This is not difficult to understand, for France had never been a maritime

power and Napoleon, as did his predecessors, felt that the future of France lay on terra firma. Consequently, even though Fulton built a workable submarine and demonstrated it to an official commission, his offer was ignored.

In view of his strong republican utterances it is somewhat amusing to find him negotiating with the English Ministry. Since it was not to England's advantage to have anyone construct a vessel that would destroy the military value of the entire English navy, effort was made toward seeing that Fulton was enticed to England where the secret would be safe. The tactics of the English government in dealing with the inventor are a revelation as to how to avoid purchasing an instrument and at the same time prevent its sale to others. Fulton's monthly pay of £200 was quite as much as most inventors hope for, but was insignificant in view of the disaster to the English navy if the plans were in hostile hands. Considering Fulton's demand of £100,000, it cannot be said that he suffered from modesty, the curse of too many inventors.

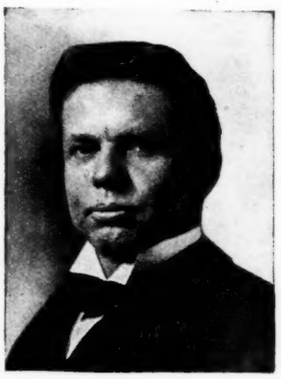
Fulton's actions in selling his services to England after failing of success with France leaves one with the feeling that his motives were not on quite so high a plane as he pretended when dealing with France. He will suffer in the estimation of many for his failure to return to America with his plans and so give his native land an opportunity to secure naval security. That he preferred to deal with the wealthier nation indicates that after all Fulton was an inventor who possessed a strong commercial sense and a not over-supply of patriotism.

The reproductions of Fulton's plans are more than interesting and his correspondence with various members of the English Ministry gives one an inkling as to why he sailed to America a bitterly disappointed man to take up the steamboat idea, which brought him more of a financial return.

The American Engineering Standards Committee has just issued its Year Book for 1923. The purpose of the committee is to serve as a national clearing house for engineering and industrial standardization, to act as the official channel of co-operation in international standardization, and to provide an information service on standardization generally. The Year Book gives the organization of the committee, with a list of the member bodies, outstanding developments in the work of the committee during the last year, an historical sketch of the genesis and organization of the committee, with lists of the projects in hand, the standards approved, the constitution, rules of procedure, etc. Copies of the Year Book and information concerning the society's activities may be obtained by addressing Dr. P. G. Agnew, Secretary, American Engineering Standards Committee, 29 West 39th St., New York City.

Obituary

Schuyler Skaats Wheeler, the noted engineer, who died suddenly on April 20, 1923, was born May 17, 1860 in New York City. He was educated at Columbia grammer school and Columbia College. Upon graduation in 1881 he became assistant electrician of the Jablochkoff Electric Light Co., and later he was connected with the United States Electric Lighting Co. At the time when incandescent light was introduced he was on Edison's engineering



SCHUYLER S. WHEELER

staff which was in charge of the work of starting the first station, and he contributed many of the devices adopted. He later erected the station apparatus at Fall River, and at Newburgh.

In 1886 Dr. Wheeler was manager of the first concern established for the regular manufacture of electric motors, in the development of which he was prominent, especially in the application of electricity to driving tools. He was the inventor of numerous electrical and mechanical devices such as the electric elevator, electric fire engine, series multiple motor control, paralleling of dynamos and other devices. The John Scott Medal, was given to him by the Franklin Institute for the invention of the electric buzz fan in 1904. In 1887 he founded the Crocker-Wheeler Co., for the manufacture of motors. They located near East Orange, N. J., and called the new town Ampere.

The library known as the "Wheeler Gift," which comprises the Latimer Clark Library, the largest collection of rare electrical books in existence, was presented by him to the A.I.E.E. in 1901. This library led to the organization and building of the Engineering Societies Building, 29 West 39th St., New York City.

The code of professional ethics for engineers, which was adopted by the A.I.E.E in 1912, was written by him and he was joint author with Prof. Francis B. Crocker in 1884, of "Practical Management of Dynamos and Motors." He was a member and past president of the A.I.E.E. and a member of the A.S.M.E., A.S. of C.E.

Personal Mention

John W. Lieb, of the New York Edison Co., has been called upon by F. R. Wadleigh, Federal Fuel Distributor, for suggestions with regard to providing coal storage this year, so that the public utilities may be encouraged to continue the practice of last year.

W. L. Abbott, of Chicago, has been named chairman of the Committee representing the Federated American Engineering Societies, to make a nation wide coal-storage survey in co-operation with the United States Coal Commission and the Department of Commerce.

H. W. Dickinson, curator of the Science Museum, South Kensington, London, and secretary of the Newcomen Society, is visiting America, primarily to lend his wealth of knowledge of the history and traditions of engineering to the celebration of the centenary of the organization of the Delaware and Hudson Company.

Society Affairs

The Metropolitan Section of the A.S.M.E. will hear Senator Thomas Sterling of North Dakota and Admiral John Keeler Robinson, Engineer in Chief, United States Navy, on "The Engineer in Public Affairs," on May 8, at 29 West 39th St., New York City.

Société des Ingenieurs Civils de France, Section Americaine, and the **A.S.C.E., A.I.M.E., A.S.M.E.** and **A.I.E.E.** are to hold a joint meeting at the Engineering Building, 29 West 39th St., New York City, on May 4, to celebrate the 75th anniversary of the founding of the French Society. Prominent French and American engineers will address the meeting.

The American Society of Heating & Ventilating Engineers will have an attractive program for their semi-annual meeting, May 21-23, at the Drake Hotel, Chicago, Ill. There will be discussions on code of heating and ventilating equipment, a research session, a heating session, and a ventilation session. The papers to be delivered will be announced later.

The Joint Committee of the A.I.E.E., A.S.C.E., A.I.M.&M.E., A.S.M.E. on A National Museum of Engineering and Industry proposes to hold during the fall and winter, at the Engineering Building, 29 West 39th St., an exhibit of records, charts, drawings, pictures, models and other material which will illustrate the principal steps supplied by the engineer in the development of our country from an agricultural populace to the leading industrial nation of the world. The object of the exhibition is to arouse the interest of the engineers and the public in the establishment of a National Museum of Engineering and Industry in connection with

the Smithsonian Museum with headquarters in Washington, D.C., and branches in various sections of the country.

The American Welding Society has been holding its annual meeting and has elected new officers as follows: President, T. F. Barton; vice-president, Pacific Coast Division, A. V. Thompson; vice-president, Southern Division, C. L. Jones; directors at large, C. A. Adams, H. S. Smith, A. M. Candy, C. J. Holslag. It was voted to hold the October meeting at Pittsburgh. Much appreciation was expressed of the services rendered to the society by the retiring president, C. A. McCune.

The A.S.M.E. is arranging an automobile caravan to the Spring Meeting, which is to be held in Montreal, May 8. Interest in the trip is increasing daily. Past President Worcester R. Warner, visiting the headquarters of the Society this week, stated his desire to participate, and replies have been received from practically all the Local Sections in New England and the East, indicating that quite a number of automobiles will be in line when the 26th of May arrives. Even members as far west as Milwaukee are getting into line. The Secretary of Milwaukee, Fred H. Dorner, has signed up for the trip. All members who would be interested in this trip are requested immediately to notify the headquarters of the Society, indicating whether they will drive their own car and whether they will be able to accommodate any other members who might not have cars, but who would of course be willing to share in the expense of the trip. The itinerary for those south of Albany would be to leave New York City on Saturday morning on a schedule that would bring them to Albany late in the afternoon, where a stop would be made over night. Sunday a run from Albany to Plattsburg would be made, the party remaining there over night, completing the trip about noon Monday. Information regarding garage space, etc., will be provided to all those desiring to make the trip. Members in the territory of a Local Section should communicate with the chairman of the Section, sending a carbon copy to the Society headquarters at New York. Detailed information regarding the itinerary will be sent to all members in the special circular to be issued early in May, regarding the Spring Meeting.

Coming Meetings

American Association of Engineers; C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual convention at Norfolk, Va., May 7-9.

American Boiler Manufacturers' Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Thirty-fifth Annual Convention at Hot Springs, Va., June 4-6.

American Order of Steam Engineers; W. J. Brice, 2126 S. 57th St., Philadelphia, Pa. 37th Annual Convention at Reading, Pa. (instead of Philadelphia, as formerly announced), June 4-8.

American Society for Testing Materials; C. L. Warwick, 1315 Spruce St., Philadelphia, Penn. Annual meeting at Atlantic City, N. J., June 25-30.

American Society of Heating & Ventilating Engineers; O. W. Obert, 29 West 39th St., New York City. Semi-annual meeting, Chicago, May 21-23.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Spring meeting at Montreal, Canada, May 28-31.

American Society of Refrigerating Engineers; W. H. Ross, 154 Nassau St., New York City. Spring meeting at St. Louis, Mo., April 30, May 1-2.

American Water Works Association, 163 W. 71st St., New York City. Annual meeting at Detroit, Mich., May 21-25.

Canadian Association of Stationary Engineers; Gordon C. Keith, 51, Wellington St. West, Toronto, Canada. 34th Annual Convention at Toronto, Canada, June 25-28.

Electric Power Club; S. N. Clarkson, Kirby Bldg., Cleveland, Ohio. Annual meeting at Hot Springs, Va., June 11-14.

International Railway Fuel Association; J. G. Crawford, 702 East 51st St., Chicago. Annual meeting at Cleveland, Ohio, May 21-24.

National Association of Manufacturers; George S. Boudinot, 50 Church St., New York City. Annual conference, New York City, May 14-16.

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Buffalo, N. Y., Sept. 10-15. Annual conventions and exhibitions of the State Associations scheduled as follows: **Indiana,** at La Fayette, Ind., May 28-29; T. J. Kelly, 2704 South St., La Fayette, Ind. **New Jersey,** at Trenton, N. J., June 1-3; Samuel Clark, 67 Columbia St., Jersey City, N. J. **Illinois,** at Springfield, Ill., June 6-9; F. W. Raven, 417 South Dearborn St., Chicago. **New England States Association,** at Manchester, N. H., July 12-14; James F. Morgan, 53 Devonshire St., Boston, Mass. **Iowa,** at Mason City, Iowa, June 11-14; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.

National District Heating Association, D. L. Gaskill, Greenville, Ohio. Annual convention at Cedar Point, Ohio, June 20-23.

National Electric Light Association; M. H. Aylesworth, 29 West 39th St., New York City. Annual meeting at New York City, June 4-8.

Stoker Manufacturers' Association; J. G. Worker, Eau Claire, Wis. Annual convention at Lake Placid Club, Essex Co., N. Y., May 29-31.

Trade Catalogs

Gas Analyzers—Jos. W. Hays, Corp., Michigan City, Ind. Leaflet containing detailed operating instructions and interesting and valuable information for those who are considering the purchase of this type of instrument.

Pipe, Joint—National Tube Co., Pittsburgh, Pa. Booklet describing and illustrating the use of this piping for high or low pressure, natural or artificial gas lines, water works, mines, mining, hydro-electric plants, irrigation and engineering uses.

Roto Tube Cleaners—Roto Co., Hartford, Conn. Catalog containing illustrations, descriptive text and charts of fuel losses. These cleaners are air, steam or water driven for fire-tube and water-tube boilers, fuel economizers, condensers, evaporators, feed-water heaters, locomotive arch tubes and oil stills.

Belting, Leather—Chas. A. Schieren Co., 69 Cliff St., New York City. Handbook, which is intended to be a practical manual on belting and power transmission for the engineer, plant executives, production managers, maintenance men, factory superintendents, foremen and purchasing agents. The book is being published in sections to give the readers a chance to go over the separate sections carefully as they are released. When completed, it will form practically th only book of its kind in circulation. Facts regarding the transmission of power by means of leather belts; discussion of the different types of drives; belting rules and ratings; horsepower; care and operation; proper methods of joining ends of belts; alignment of drives; moist conditions; V and round belting; comparative operating cost of leather and rubber belting; data on how leather belts are made; plant layout, showing methods for the most economical arrangement of belt drives; locating motors; sizes of shafting; short drive; belt troubles and remedies for them; tables for application of belt brands to suited drives—these and other matters are taken up in a practical and usable way.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Apr. 16, 1923	Apr. 23, 1923
Pool 1,	New York	$3.50–4.50	$3.50–4.25
Smokeless,	Columbus	4.00–4.50	4.00–4.50
Clearfield,	Boston	2.40–3.50	2.25–3.25
Somerset,	Boston	3.00–3.75	2.85–3.50
Kanawha,	Columbus	2.00–2.50	2.00–2.50
Hocking,	Columbus	2.00–2.25	1.85–2.20
Pittsburgh No. 8	Cleveland	2.15–2.35	2.10–2.25
Franklin, Ill.,	Chicago	3.00–3.25	3.00–3.25
Central, Ill.,	Chicago	2.00–2.25	2.00–2.25
Ind. 4th Vein,	Chicago	2.75–3.00	2.75–3.00
West Ky.,	Louisville	2.00–2.25	2.00–2.25
S. E. Ky.,	Louisville	2.50–3.00	2.50–2.75
Big Seam,	Birmingham	2.00–2.25	2.00–2.25

FUEL OIL

(f.o.b. city unless otherwise specified)

New York—April 26, Port Arthur light oil, 22@25 deg. Baumé, 5⅜c. per gal.; 30@35 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

Chicago — April 14, 24@26 deg. Baumé, $2.12 per bbl.; 32@36 deg., $2.33 per bbl. tank cars.

Philadelphia—April 23, 26@28 deg. Baumé, Oklahoma, $1.10@$1.20 per bbl.; 30@34 deg., Oklahoma (group 3), 3⅛@3⅜c. per gal.; 16@20 deg. Seaboard, $1.75@$1.90 per bbl.

St. Louis—April 17, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2 per bbl.; 26@28 deg., $2.05 per bbl.; 28@30 deg., $2.10 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 36@40 deg., distillate 5⅞@6c. per gal.

Pittsburgh—April 16, f.o.b. local refinery, 30@34 deg., fuel oil, 5⅜c. per gal.; 36@40 deg., fuel oil, 6c. per gal.; 34 deg., neutral, 9½c. per gal.

Dallas—April 14, f.o.b. local refinery, 26@30 deg., $1.61 per bbl.

New Plant Construction

PROPOSED WORK

Calif., Eureka—The Englehart Paving & Constr. Co. is in the market for one stationary or marine type gasoline engine, 75 or 100 hp.

Calif., Long Beach—C. H. Leitch, c/o W. H. Austin, et al., Archts., First Natl. Bank Bldg., is having preliminary plans prepared for the construction of a 10 story hotel apartment building on 5th and Locust Sts. Estimated cost $350,000.

Calif., Los Angeles—The Los Angeles Gas & Electric Corp., 645 South Hill St., is having plans prepared for the construction of a 12 story office building on Flower St. Cost will exceed $500,000. Parkinson & Parkinson, Title Insurance Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., Los Angeles—E. A. Wayt, representing a syndicate, is having plans prepared for the construction of a 13 story, 100 x 150 ft. apartment building on 6th and Carondelet Sts. Estimated cost $800,000. Russell & Alspaugh, Story Bldg., Los Angeles, Archts. Equipment detail not reported.

Calif., Marysville—The Pacific Gas & Electric Co., 445 Sutter St., San Francisco, plans additions to substation, here. Estimated cost $50,000. Private plans.

Calif., Salinas—The Constructing Quartermaster, Fort Mason, San Francisco, will soon receive bids for the construction of a summer training camp, including deep wells, pumps, power lines, roads, sewers, camp buildings, 200,000 gal. tank, etc., at Gihling Reservation, 3½ miles from Hilltown.

Colo., Ward—C. W. Thuringer, Engr., East 42nd and Josephine Sts., Denver, is preparing plans for the installation of a Sethman new process electric smelter and a 40,000 hp. hydro-electric plant, here. Estimated cost $500,000. Owner's name withheld.

Conn., New Haven—The Masonic Temple Assoc., 87 Church St., is having revised plans prepared and will soon receive bids for the construction of a 6 story, 80 x 160 ft. masonic temple including steam heating system on West Chapel St. Estimated cost $500,000. Norton & Townsend, 839 Chapel St., Archts.

Conn., South Norwalk—The Dept. Public Wks., City Hall, is having plans prepared for the construction of a 3 story addition to the municipal power plant on Wharf St. Estimated cost $300,000. Westcott & Mapes, 207 Orange St., New Haven, Engrs. and Archts.

Ga., Milltown—The Lanier County Power Co. plans to build a hydro-electric plant on Lake Irma. Estimated cost $350,000.

Ill., Astoria—The city received bids for the construction of complete water works and distribution system, including two filter units, 100,000 gal. each; four centrifugal pumps; dam; two mi. of 6 in. and two mi. of 4 in. c.i. pipe; sixteen fire hydrants, etc.; from Nixon & Healey, 21st and State Sts., East St. Louis, $60,000; E. K. Ladd, 3229 Harrison St., Kansas City, Mo., $69,000; James & Anderson, Astoria, cost plus. W. A. Fuller Co., 1917 Ry. Exch. Bldg., St. Louis, Mo., Engrs. Noted Mar. 20.

Ill., Chicago—The Fair Co., 140 South State St., is having plans prepared for the construction of a 4 story, 190 x 351 ft. addition to its department store, including steam heating system. Estimated cost $2,000,000. Mundie & Jensen, 39 South La Salle St., Chicago, Archts.

Ill., Chicago—The Hotel Harper Corp., 6236 Harper Ave., is having plans prepared for the construction of an 11 story, 182 x 185 ft. hotel, including steam heating system. Estimated cost $4,500,000. Fridstein & Co., 111 West Washington St., Chicago, Engrs.

Ill., Chicago—The Jackson Shore Hotel Co., c/o Fridstein & Co., Engrs., 111 West Washington St., is having plans prepared for the construction of an 11 story, 193 x 324 ft. hotel, including steam heating system, at 5450-84 Shore Rd. Drive. Estimated cost $5,500,000.

Ill., Chicago—V. C. Magill, c/o W. W. Ahlschlager, Archt., 65 East Huron St., is having plans prepared for the construction of a 7 story apartment house, including steam heating system, on Lake Shore and Sherwin Aves. Estimated cost $1,250,000.

Ill., Chicago—Weller & Rippel, Inc., Archts., 140 South Dearborn St., are preparing plans for the construction of a 16 story, 100 x 150 ft. hotel, including steam heating system, on Walton St. near Delaware Ave. Estimated cost $3,000,000. Owner's name withheld.

Ill., Chicago—The Western Electric Co., 52nd and Cicero Sts., is having plans prepared for the construction of a 4 story addition to its plant, in the suburb of Hawthorne. Estimated cost $1,000,000. W. R. Kattelle, c/o owner, Archt. Equipment detail not reported.

Ill., White Hall—The city voted $54,000 bonds for the construction of a municipal electric light plant.

Ind., Vincennes—The Blackford Window Glass Co. is in the market for power house equipment.

Ia., Des Moines—W. Lister, 507 Youngeman Ave. (engine shop work), is in the market for a return tube boiler, 54 or 60 in. x 14 or 16 ft., 100 lb. pressure.

Ia., Sioux City—The Sioux City Gas & Electric Co., W. J. Berke, Mgr., 509 Pierce St., plans the construction of a power plant. Estimated cost $2,500,000.

Kan., Wichita—The Benham Eng. Co., 512 Gumbel Bldg., has submitted a report on the cost of power production and proposed plant improvements for the Kansas Milling Co., 715 East 13th St., here.

Ky., Louisville—U. S. Engineers Office, L. S. Ehrman, Purch. Agt., P. O. Box 72, is in the market for a 16 in. centrifugal pump with shaft and motor base, to deliver 7,000 to 10,000 g.p.m.

Md., Baltimore—Archer & Allen, Archts., 1 East Lexington St., will receive bids until May 5 for the construction of a 9 story, 60 x 170 ft. school of hygiene on Wolfe and Monument Sts. for Johns Hopkins Hospital. Estimated cost $750,000. Tenney & Ohmes, 101 Park Ave., New York, Consult. Engrs. Equipment detail not reported.

Mass., Boston—The Audubon Realty Co., 18 Tremont St., will build a 5 story apartment building, including steam heating and ventilating systems. Estimated cost $750,000.

Mass., Holyoke—The city plans to build an electric power plant off Hampden St. Estimated cost $1,000,000.

Mich., Detroit—E. Bollin and R. W. McKinney, c/o Kohner & Seeler, Archts., 405 Kresge Bldg., are having plans prepared for the construction of a 10 story, 100 x 150 ft. hotel, including steam heating plant with boiler and accessories, on John R. St. Estimated cost $350,000.

Mich., Detroit—A. V. Lee, c/o L. Kamper, Archt., Kamper Bldg., Cass Ave., is having plans prepared for the construction of a 9 story, 60 x 125 ft. apartment hotel, including steam heating plant, on Sproat St. and Park Blvd. Estimated cost $350,000.

Minn., Willmar—The city is having plans prepared for the construction of a municipal electric power plant and waterworks system. Estimated cost $157,600. Cory & LeCocq, Aberdeen, S. D., Engrs. Noted Feb. 27.

Mo., Kansas City—Wheatley Bros., 1906 Wyandotte St., are in the market for a 60 hp. 22 volt, 3 phase engine.

Mo., Webster Groves (St. Louis, P. O.)—O. Rosegren, International Life Bldg., St. Louis, is having plans prepared for the construction of several 6 story, 50 x 90 ft. apartment buildings on Lockwood Ave., here. Estimated cost $1,000,000. P. J. Bradshaw, c/o owner, Archt. Equipment detail not reported.

Neb., Chester—The village, E. A. Garvan, Clk., will receive bids until May 7, for a waterworks system, including 1 motor driven deep well pump, 100 g.p.m. capacity, 15 hp. electric motor 3 phase, 220 volts; one 8 in. well, 150 ft. deep; one 40,000 gal. steel tank on tower 90 ft. in height. Estimated cost $30,000. Grant, Fulton & Letton, 505 Bankers Life Bldg., Lincoln, Engrs.

N. J., Glen Gardner—The state plans to install boiler and other equipment in power house at the New Jersey Sanitarium, here. Estimated cost $10,300. A. B. Mills, State Office Bldg., Trenton, Engr.

N. J., New Lisbon—The state, B. G. Lewis, Comr. of Charities and Corrections, Trenton, is having plans prepared for the construction of a 40 x 56 ft. ice plant and power house, including installation of boiler, at the Colony for Feeble Minded, here. Estimated cost $26,000. A. B. Mills, State Office Bldg., Trenton, Engr.

N. Y., Belfast—The village is in the market for air compressors, engines and other power house equipment, to replace that destroyed by fire.

N. Y., Dolgeville—The Adirondack Power & Light Corp., 511 State St., Schenectady, plans the construction of a new dam and power house on East Canada Creek, Stewarts Landing. Estimated cost to exceed $175,000.

N. Y., New York—G. and H. Boeham, Archts., 587 5th Ave., have prepared plans for the construction of a 12 story, 50 x 100 ft. apartment building on Madison Ave. and 70th St. Owner's name withheld Equipment detail not reported.

N. Y., New York—The Dept. of Public Markets, c/o E. J. O'Malley, Municipal Bldg., will soon receive bids for the construction of a 7 story, 310 x 330 ft. market terminal building on the Harlem River and Cromwell St. Estimated cost $5,000,000. Private plans. Equipment detail not reported.

N. Y., New York—The F. F. French Co., 350 Madison Ave., will build a 15 story apartment building on Park Ave., by separate contracts. Equipment detail not reported.

N. Y., Rochester—The Rochester Gas & Electric Corp., Clinton Ave., N., plans to build a transformer station at 26 Swan St. Cost between $40,000 and $45,000.

N. Y., Rochester—J. Strobel, Archt., 52 Lake View Park, is in the market for a 30 ton daily capacity ice making machine for cold storage warehouse at Charlotte.

N. Y., Rochester—G. A. Wenger, 12 Amherst St., is in the market for additional ice manufacturing machinery and equipment.

N. Y., Watertown—The Taggart Bros. Paper Co., West Main St., J. Taggart, Purch. Agt., is in the market for a 1,200 lb. beating engine and a 60 to 75 hp. moisture proof motor.

N. C., Andrews—The Bd. of Aldermen, P. E. Ferebee, Mayor, has authorized a $350,000 bond issue for the construction of a dam and hydro-electric plant on the Hiawassee River, to develop 1,500 hp. for supplying local industries. The Ludlow Engrs., Winston-Salem, Engrs.

N. C., Ashville—G. Vanderbilt and Battery Park Hotel Cos. will soon award the contract for the construction of a hotel. Estimated cost $1,500,000. W. L. Stoddart, 9 East 40th St., New York, Archt. Equipment detail not reported.

N. C., Chapel Hill—The University of North Carolina, H. W. Chase, Pres., plans the construction of sewers, heating and lighting systems. Estimated cost $115,000. The T. A. Atwood Corp. Chapel Hill, Engrs.

N. C., Fayetteville—The Carolina Power Co., a subsidiary of the Carolina Power & Light Co., Raleigh, P. A. Tillery, Genl. Mgr., plans to build a power plant and substation, here. Estimated cost $750,000.

Ohio, Cleveland—The Bd. of County Comrs. is having plans prepared for the construction of a pumping station, water mains and elevated tanks for Mayfield Twp. Estimated cost $100,000. R. F. MacDowell, Court House, Cleveland, Engr.

Ohio, Cleveland—The Fairview Park Hospital, 3305 Franklin Ave., F. H. Diehm, Supt., is having plans prepared for the construction of a 2 story nurses' home, also boiler house and laundry. Estimated cost $150,000. H. W. Striebinger, 1900 Euclid Ave., Cleveland, Archt.

Ohio, Cleveland—L. J. Lesser, 38 South Dearborn St., and Paschen Bros., 111 West Nash St., Chicago, Ill., are having plans prepared for the construction of a 16 story, 82 x 150 ft. addition to office building, including steam heating system, on East 6th St. and Superior Ave., here. Estimated cost $2,000,000. W. W. Ahlachlager, 65 East Huron St., Chicago, Ill., Archt.

Ohio, Cleveland—The Natl. Dept. Stores Co., c/o V. Sincere of the Bailey Co., Ontario St. and Prospect Aves., plans to build a 10 story, department store to contain 630,000 sq.ft. of floor space, including steam heating system, on East 95th St. and Euclid Ave. Estimated cost $2,000,000. Engineer or architect not announced.

Ohio, Cleveland—St. Ignatius College, c/o T. J. Smith, Pres., West 30th St. and Carroll Ave., plans to build a group of college buildings on Fairmount Blvd. Estimated cost $2,000,000. Engineer or architect not selected.

Ohio, Shaker Heights (Cleveland, P. O.)—The University School, c/o A. C. Brown,

4403 St. Clair Ave., Cleveland, plans to build 4 story school buildings, including administration building, recitation halls, dormitories and gymnasium, with steam heating system, on Warrensville Center Rd., here. Estimated cost $1,000,000. Engineer or architect not selected.

Okla., Nowata—The city will vote on a $105,000 bond issue for the construction of a rapid sand mechanical water filtration plant, improvements to pumping station, additions to pipe lines, 1,000,000 gal. storage reservoir and pumping equipment. Benham Eng. Co., 512 Gumbel Bldg., Kansas City, Mo., Engrs. Noted Apr. 3.

Pa., Ebensburg—The Cambria County Comrs. and Johnstown Society for the Prevention of Tuberculosis have had plans prepared and will receive bids about June 1 for the construction of a hospital, including 2 story 90 x 315 ft. main building and 94 x 160 ft. service building, also a 40 x 70 ft. laundry and boiler house with sterilization plant. Estimated cost $300,000. W. R. Myton, 1204 1st Natl. Bank Bldg., Johnstown, Archt. Noted Mar. 13.

Pa., Forest City—The Forest City School Dist., W. H. Jones, Acting Secy., will receive bids May 3 for furnishing and installing heating and ventilating equipment for No. 3 High School. Estimated cost $25,000.

Pa., Phila.—The Stiegerwalt Boot Shop, 1420 Chestnut St., is having plans prepared for the construction of a 5 story, 40 x 150 ft. store and office building at 1526 Chestnut St. Estimated cost $500.000. W. Steele & Sons, 219 North Broad St., Archt. Equipment detail not reported.

Pa., Phila.—Sugarman, Hess & Berger, Archts., 16 East 43 St., New York, are receiving bids for the construction of a 15 story, 42 x 95 ft. apartment building on 19th and Rittenhouse Sts. for the Rittenhouse Apt. Estimated cost $2,000,000. Equipment detail not reported.

Pa., Reading—The Confederated Home Abattoirs Co., Amer. Casualty Bldg., will receive bids until May 15 for the construction of a 5 story, 140 x 150 ft. slaughter house. Estimated cost $1,000,000. Private plans. Equipment detail not reported.

Pa., West Chester—The Memorial Hospital Assn., is having plans prepared and will soon receive bids for the construction of a 2 story, hospital. Estimated cost $600,000. Day & Klauder, Franklin Bank Bldg., Phila., Archt. Equipment detail not reported.

Pa., Woodlawn—The Woodlawn Water Co. is receiving bids for the construction of a 1 and 3 story, 56 x 115 ft. pump station and filter building; a coagulation basin, 500,000 gal. capacity; filtered water reservoir, 300,000 gal. pumping equipment, consisting of two 2,000,000 gal. and one 1,000,000 gal. capacity centrifugal pumps, high pressure piping and steel tanks. Estimated cost $200,000. Morris Knowles Co., Westinghouse Bldg., Pittsburgh, Engrs.

Tex., Bonham—The Catron Mfg. Co. is in the market for one 50 hp. 3 phase 60 cycle 111 volt motor and a 2 hp. 3 phase 60 cycle 110 volt motor.

Tex., Granbury—A. T. Keith, Mayor, and city council will receive bids until May 9, for two crude oil engines, directly connected to alternators, two motor driven centrifugal pumps, air compressor, switchboard, pipe, steel tank and tower hydrants, valves, etc. Municipal Eng. Co., 715 Praetorian Bldg., Dallas, Engrs. N. Heiner, City Secy.

Tex., Urbana—The Urbana Sand & Gravel Co. is in the market for a 60 kw. 3 phase 440 volt generator, exciter and a 75 hp. 3 phase 440 volt slip motor with starter.

Tex., Wills Point—The city, H. Gilchrist, Mayor, voted $25,000 bonds for the construction of a municipal electric light plant. Noted Mar. 27.

Va., Altavista—Lockwood, Greene & Co., Engrs., 24 Federal St., Boston, are receiving bids for the construction of a boiler house, containing two 300 hp. Babcock & Wilcox boilers, with Dutch oven setting for burning either wood waste or coal, for the Lane Co., manufacturer of red cedar chests, here.

Va., Norfolk—The Taylor Parker Co., Inc., 47 Commercial Pl., is in the market for a 300 hp. 4 valve automatic engine.

Va., Richmond—The Hackley Morrison Co., 1708 Lewis St., is in the market for 72 in. x 18 ft. and 66 in. x 16 ft. high pressure boilers, (used), 80 hp. horizontal boiler, 125 lb. steam pressure on skids, to pass Penn. spec.; left-hand heavy duty Corliss engine 26 x 60 or 30 x 60 with balance fly-wheel, (used) and a 100 kw. direct connected generator unit, 3 phase, 60 cycle, 600 volt.

Wash., Tacoma—The city is having plans prepared for hydro-electric development at Lake Cushman, involving construction of storage dam, approximately 220 ft. high above stream level, about 290 ft. long on top and 90 ft. long on bottom; power houses, one equipped with 30,000 hp. capacity and one equipped with penstocks, generators, etc., developing 45,000 hp.; transmission lines will be constructed from power plants here. J. L. Stannard, 702 Balboa Bldg., San Francisco, Calif., Engr. Noted Nov. 21.

Wis., Evergreen—G. Greenfield is in the market for machinery for proposed creamery, including power churns, testors and refrigeration machinery.

Wis., Kaukauna—The Thilmany Pulp & Paper Co. plans to build a steam generating plant. Estimated cost $50,000. Engineer or architect not selected.

Wis., La Crosse—The Weisel Mfg. Co. is in the market for boiler and generating equipment.

Wis., Madison—The Bd. Educ., T. W. Gosling, Secy., is having plans prepared for the construction of a 2 story, 75 x 150 ft. auditorium, gymnasium and heating plant at East Side High School. Estimated cost $200,000. F. Riley, Conklin Bldg., Madison, Archt.

Wis., Portage—The city, C. J. Loomis, Clk., plans the construction of waterworks plant, pump and several deep wells. Estimated cost $160,000. Engineer or architect not selected.

Wis., Woodville—The city, J. T. Heneppe, Clk., will receive bids until May 14th, for the construction of a waterworks system, including pump house and one deep well pump. Estimated cost $32,000. Druar & Milinowski, 500 Globe Bldg., St. Paul, Engrs.

Ont., Brantford—The Brandon Shoe Co., is having plans prepared for the construction of a 2 story, 60 x 160 ft. factory building, boiler house and outside elevator to replace buildings destroyed by fire. Estimated cost $75,000. Private plans. Prices wanted on all materials and complete machinery and equipment.

Ont., Durham—The City is having a report and estimates prepared for the construction of a waterworks system, including c.i. mains, electric centrifugal pumps, pump house, reservoir or tank, filters, etc. Estimated cost $75,000. James, Proctor & Redfern, Ltd., 36 Toronto St. ,Toronto, Engrs.

Ont., Hanover—The city, J. Taylor, Clk., will receive bids until May 10 for the construction of a waterworks system, including gate valves, relief valves, valve boxes, fire hydrants, electrically driven 3 stage centrifugal pumps with gasoline auxiliary, electric motors, gasoline engine, brass screens, chlorinator, pumphouse, reservoir and laying of mains. Estimated cost $125,000. F. W. Thorold Co., Ltd., 54 Admiral Rd., Toronto, Engrs. Noted Nov. 21.

Ont., Orillia—The city plans the construction of a municipal heating plant, including boilers and equipment to use soft coal. Engineer or architect not selected.

Ont., Point Edward—The Sarnia Cement Products Co. is rebuilding its 1 story, 60 x 100 ft. plant and plans to install three dry kilns, cupola and one 30 hp. electric motor.

Ont., St. Catharines—The city, J. A. Pay, Clk., plans the construction of a skating arena with an artificial ice surface. Estimated cost $150,000.

Ont., Toronto—Gowans Kent, Ltd., 16 Front St., E., plans the construction of an 8 story factory for manufacture of glass, including steam heating system and freight and passenger electric elevators at 20 Front St., W. Estimated cost $300,000. Architect not selected.

Que., Montreal—The Sisters of Providence, 149 Fullum St., S. Amanire, Superior Genl., plan to rebuild hospital for incurables which was destroyed by fire. Estimated cost $1,000,000.

CONTRACTS AWARDED

Calif., Los Angeles—R. Stern, c/o E. Frazier, Archt., Regent Apartments, awarded the contract for the construction of a 10 story store and office building on Hollywood St. to the Heitman Constr. Co., Merriett Bldg., Los Angeles. Estimated cost $725,000. Equipment detail not reported. Noted Apr. 24.

Calif., Newman—The Natl. Ice Cream Co., 371 Guerrero St., San Francisco, awarded the contract for concrete work on addition to ice plant, here, to Shepherd & Riley, c/o Builders' Exch., Stockton. Estimated cost $15,000, ultimate cost $40,000.

Colo., Denver—The Bd. of Water Comrs. awarded the contract for one 4,000,000 gal. electrically driven De Laval centrifugal pumping unit for the South University Park Sta.; one 8,000,000 gal. electrically driven De Laval centrifugal pumping unit for the Ashland Ave. Sta.; one 10,000,000 gal. De Laval steam turbine driven centrifugal pumping unit with condenser for the Park Hill Sta. to the Advance Mchy. & Supply Co., Railroad Bldg., Denver, representing The De Laval Steam Turbine Co., North Clinton St. along tracks of Pennsylvania R.R., Trenton, N. J.

Ill., Chicago—Holton, Seelye & Co., 140 South Dearborn St., awarded the contract for the construction of an 11 story, 75 x 137 ft. hotel at 6400-6408 South Woodlawn St. to H. Janisch & Co., 1813 Winona St. Estimated cost $750,000. Steam heating system will be installed.

Ind., Crawfordsville—R. R. Donnelley & Sons Co., Plymouth and Polk Sts., awarded the contract for the construction of a 1 story, 150 x 300 ft. printing plant to the Austin Co., 208 South La Salle St., Chicago. Estimated cost $1,000,000. Steam heating system will be installed. Noted Feb. 13.

Mich., Dearborn—The Dearborn Publishing Co. awarded the contract for the construction of a 2 story, 50 x 235 ft. building, including engineering laboratory and printing plant, to the H. G. Christman Co., 315 Stevens Bldg., Detroit. Estimated cost $1,000,000. Steam heating equipment included in contract.

Mich., Pontiac—The Fisher Body Corp., General Motors Bldg., Detroit, awarded the contract for the construction of two 1 story and one 2 story, 150 x 500 ft. units of automobile body plant, including steam heating equipment, on Baldwin Ave., here, to the J. A. Utley Co., 718 Penobscot Bldg., Detroit. Estimated cost $2,000,000. Noted Feb. 27.

N. J., Camden—The Reading R.R., Reading Terminal, Phila., Pa., awarded the contract for the construction of terminal buildings, consisting of a 42 x 115 office building, 105 x 328 concourse, Y.M.C.A. building, power house, etc., to the New York Ship Bldg. Corp., Bway and Fairview St., Camden. Estimated cost $2,000,000.

N. Y., Buffalo—The city awarded the contract for the construction of Bennett High School on Main St. to C. H. Everett, 295 Auburn Ave., Buffalo, $1,406,000; heating and ventilating to the Power Efficiency Corp., White Bldg., Buffalo, $197,785.

Ohio, Cleveland—The city, R. Perkins, Dir. of Public Wks., City Hall, awarded the contract for the construction of a 2 story, 40 x 250 ft. hospital at Warrensville Farm to the Central States Eng. & Constr. Co., 809 Union Natl. Bank Bldg., Cleveland, $225,600. Steam heating system will be installed.

Ohio, Cleveland—The city awarded the contract for the construction of 180 x 193 ft. superstructure of Fairmont Pumping Station to Schirmer O'Hara Co., 2031 Euclid Ave., $516,568. Noted April 3.

Pa., Jeannette—The Amer. Window Glass Co., Farmers Bank Bldg., Pittsburgh, awarded the contract for the construction of a 1 story, 42 x 160 ft. gas producer building, a 42 x 102 ft. boiler house and a 48 x 84 ft. power house, here, to the Bollinger-Andrews Constr. Co., Empire Bldg., Pittsburgh. Noted Mar. 27.

R. I., Providence—The Narragansett Electric Light Co., Turks Head Bldg., awarded the contract for the construction of a 4 story, 30 x 200 ft. switch house on Eddy St. to the D. R. Robinson Co., Inc., 125 East 46th St., New York. Estimated cost $1,000,000. Contractor will purchase equipment.

W. Va., Charleston—The Federal Hotel Co., Inc., awarded the contract for the construction of a 13 story, 135 x 137 ft. hotel building on Dunbar and Kanawha Sts., to the Ring Hartman Co., Inc. Estimated cost $2,000,000. Equipment detail not reported. Noted April 17.

Wis., Madison—The Madison Gas & Electric Co., 120 East Main St., J. St. John, Mgr., awarded the contract for the construction of a 2 story, 60 x 80 ft. power house to J. H. Findorff & Son, 601 West Wilson St. Estimated cost $40,000. Noted Mar. 27.

Wis., Sheboygan—The Eastern Wisconsin Electric Co., 8th St. and Pennsylvania Ave., awarded the contract for the construction of a 2 story, 75 x 200 ft. addition to power house to D. F. Davis, Sheboygan. Estimated cost $200,000. L. P. Fessenden, Engr., 428 North 8th St., Sheboygan, will purchase power machinery, generators, motors, belting and shafting.

Wis., Wauwatosa—The Forsyth Leather Co., State St., awarded the contract for the construction of a 46 x 60 ft. power house to P. Riesen's Sons, 1018 Humboldt Ave., Milwaukee. Estimated cost $40,000. Noted April 24.

Que., Montreal—The Insurance Exchange Corp., Ltd., awarded the contract for the construction of a 10 story office building on St. James St. to the Anglin, Norcros Co., Victoria St., $1,100,100. Equipment detail not reported.